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Mr. Bishop knows the Far East well, having spent altogether 18 years there. In 1915 and 1917 he conducted archeological exploration in China for the Museum of the University of Pennsylvania. In 1918 he was ordered to Peking as Assistant Naval Attaché. Since his return to the United States in 1920 he has been engaged in compilation of data collected in the Far East. He is now attached to the Freer Gallery of Art, Smithsonian Institution, Washington, D. C. To the January, 1922, number of the *Geographical Review* Mr. Bishop contributed the article "The Geographical Factor in the Development of Chinese Civilization."

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Dr. Levainville is a French geographer whose special interests lie in the field of mineral industries. He is a contributor to the *Annales de Géographie* and author of "Le Morvan" (1909); "Rouen: Étude d'une agglomération urbaine" (1913); "L'industrie du fer en France" (1922).

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Professor Davis is the leading exponent of physiography, or the rational study of land forms; to his teachings is mainly due the universal recognition of America's preeminence in this science. Among his numerous writings may be mentioned "Physical Geography" (1898); "Geographical Essays" (1909); "Die erklärende Beschreibung der Landformen" (1912), written while he was exchange professor at the University of Berlin in 1908–1909. In 1911–1912 he was visiting professor at the University of Paris. In the latter year he conducted the American Geographical Society's International Transcontinental Excursion across the United States. Professor Davis is Sturgis-Hooper Professor of Geology, Emeritus, at Harvard Univeraity.

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The American Geographical Society is the oldest geographical society in the United States. When it was founded, in 1852, there were but twelve similar societies in the world. Now it exchanges publications with more than four hundred scientific associations. The Society publishes the *Geographical Review*, a quarterly magazine issued in January, April, July, and October, and a *Research Series* of comprehensive scope. It has also a large and growing library—one of the most important geographical libraries of the world; thousands of maps and charts; and a remarkable collection of atlases of the sixteenth, seventeenth, and eighteenth centuries.

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THE GEOGRAPHICAL REVIEW

VOL. XIII JANUARY, 1923 NO. 1

LAND UTILIZATION IN THE UNITED STATES: GEOGRAPHICAL ASPECTS OF THE PROBLEM*

By O. E. BAKER

U. S. Department of Agriculture

The use made of the land by the people, or the use which should be made, constitutes the field of land utilization. In its agricultural aspects and with reference to the United States, this subject includes not only the extent, character, and productiveness of the arable and non-arable land, but also the present and prospective food, fiber, and forest-product requirements of our people. The subject, in other words, has two sides, a geographic and a demographic. The geographic side consists largely of a survey of the temperature, moisture, topography, and soil conditions which influence the utilization of land for crops, pasture, or forest; and includes also the location of the land with reference to markets for agricultural or forest products. The demographic side involves studies of population distribution and its trend both in this and other countries; the present and probable future demand, both domestic and foreign, for food and other agricultural products; and the proportion of the people engaged in farming and forestry, now and in prospect.

A TRANSITION PERIOD IN AMERICAN AGRICULTURE

The problems involved in this relationship of the people to the land are especially pressing today, because we are at a turning point in our national history. We have reached the stage in our agricultural development when there is practically no more potential agricultural land left unutilized that does not involve unprofitable expense for reclamation or clearing. Much of our agricultural land could be cultivated more intensively, however, when higher prices for agricultural commodities justify the increased costs of production.

* Read at the Joint Meeting of the Association of American Geographers and the American Geographical Society, April, 1922.

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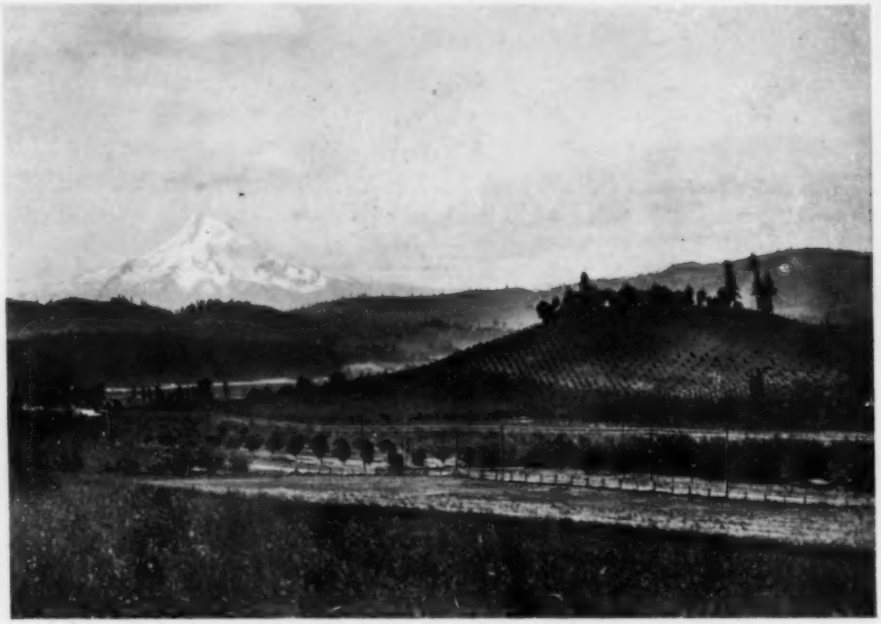

FIG. 1

FIG. 2

FIG. 1—Mt. Hood from the Hood River Valley. The utilization of land as determined by topographic conditions. The level bottom lands are used for crops and the hill slopes for pasture or fruit; the mountains are covered with forest, except the peaks above timber line. (Photograph by S. M. Thomson. All photographs used to illustrate this article are from the Bureau of Agricultural Economics, U. S. Department of Agriculture.)

FIG. 2—The most steeply rolling land in the United States used for crops planted and harvested by modern machinery is to be found, probably, in the Palouse country of eastern Washington, where this picture was taken. Still steeper slopes are planted to corn and other crops in parts of the southern Appalachians where hand methods of culture persist. (Photograph by Earl D. Strait.)

FIG. 3

FIG. 4

FIG. 3—A round-up on short-grass range land near the Santa Rita Mountains in southeastern Arizona. There are 650 million acres in the West too dry for crop production. There is enough water to irrigate only about eight per cent of this arid area: the rest must always remain grazing or desert land. (Photograph by David Griffiths.)

FIG. 4—Sunnyside Canal, Yakima Valley, Wash., showing typical contrast between the gray sagebrush desert above the irrigation ditch and the green alfalfa fields below. (Photograph by F. Lamson-Scribner.)

– The country has been settled; it is now being resettled. Certain pasture lands are being broken and some forest lands cleared for crops, while other hilly or sandy lands, formerly used for crops, are being allowed to revert to pasture or forest. Some people are leaving the land and moving to the cities, while others are taking their places on the land. Moreover, we have entered the economic arena of the world. Our exports of agricultural products are greater than ever before, but in a few years our imports may exceed our exports. It is a transition time, and our agricultural situation is uncertain. The decision our nation will soon be compelled to make with reference to land policies will affect not only our agricultural progress but also our national welfare for a century to come.

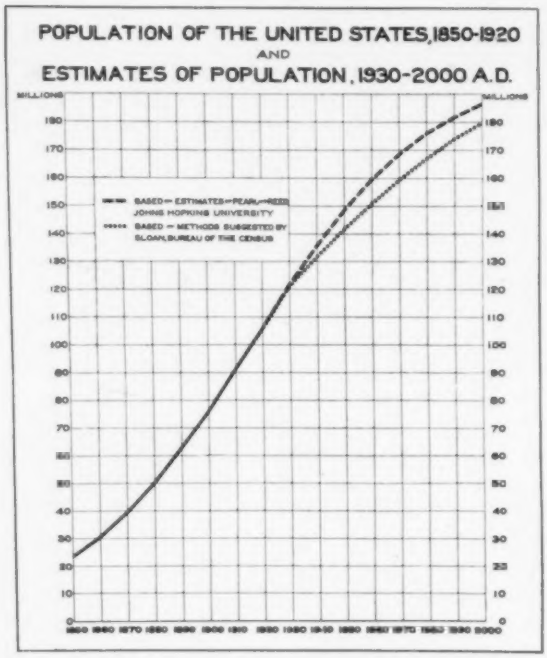

FIG. 5—Graph showing population trend of the United States.

CULTIVATED LAND INCREASING SLOWLY, POPULATION RAPIDLY

The land area of the United States is limited, and our arable land is still more limited. Because of climatic or topographic conditions, only about 40 per cent of our land area can ever be used for crops, – and most of this arable land is already so used. On the other hand, our population is inherently unlimited and is increasing at the rate of a million and a half a year. During the nineteenth century the population of the United States increased from five millions to 76 millions, or fifteen-fold, and during the first twenty years of the twentieth century the increase has been 40 per cent of the increase during the preceding century. The rate of increase, however, has declined. From the Revolutionary War to the Civil War the increase was at the almost uniform rate of 35 per cent each decade; from 1870 to 1880 population increased 30 per cent; from 1880 to 1890, 25 per cent; from 1890 to 1910, 20 per cent; and from 1910 to 1920, 15 per cent. Should even this low rate of increase during the past decade, which included the World War and several epidemics of influenza and also six years without immigration, continue, our country would have in about a century a population equal to that of China today.

However, if the population estimates of Dr. Pearl and Dr. Reed, of Johns Hopkins University, made on the basis of certain mathematical and biological deductions, are accepted, this rate of increase will not continue but will gradually diminish so that by 1950 our population will be only about 150 millions and by the end of the twentieth century will reach an almost stationary state, like that of France today, at 185 to 190 millions. A somewhat less refined method of calculation suggested by Dr. Sloane, of the Bureau of the Census, works out to a similar result of about 175 millions in the year 2000 (Fig. 5). These estimates of 175 to 185 millions of people in 2000 A.D. are, of course, subject to the vicissitudes of time; but the estimate of 145 to 150 millions in 1950, a year that many of us are likely to live to see, is reasonably safe. How to feed, clothe, house, and provide with the amenities of modern life these forty additional millions of people is the immediate problem confronting the American nation.

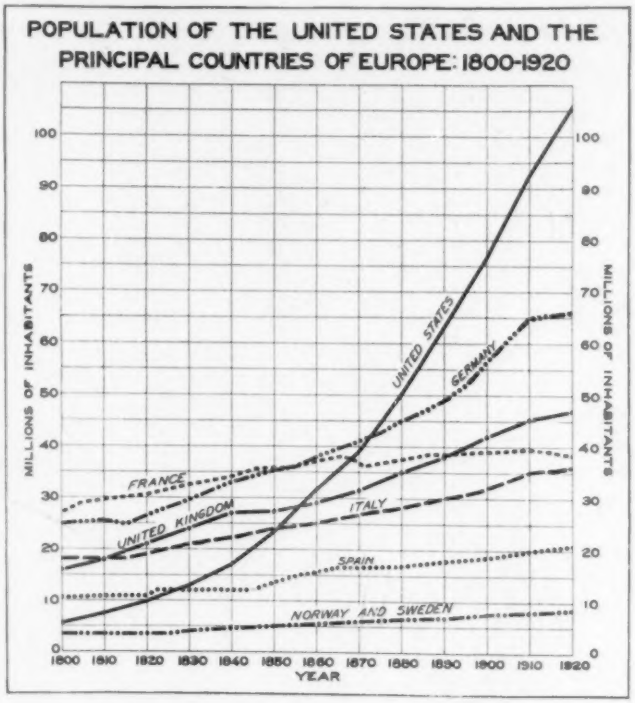
POPULATION OF THE UNITED STATES AND THE PRINCIPAL COUNTRIES OF EUROPE: 1800-1920
MILLIONS OF INHABITANTS
MILLIONS OF INHABITANTS
YEAR
1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900 1910 1920
0 10 20 30 40 50 60 70 80 90 100
UNITED STATES
GERMANY
FRANCE
UNITED KINGDOM
ITALY
SPAIN
NORWAY AND SWEDEN

FIG. 6—Graph comparing twelve decades' growth of population in the United States and principal European countries. The graph is adapted from a figure in the 1910 Census, Vol. 1, p. 35; estimates are from the Statesman's Yearbook.

Although this is a new problem to us it is an old problem in the Old World. France has found a temporary solution, at least, in limitation of population; England, in industrial development and the exchange of manufactured goods for food and raw materials from other lands; while Germany has followed England's example and also, in greater degree than France or England, has achieved notable increase in the productiveness of the land. Recently these three nations have tried the old remedy of retarding population growth by war, while Russia has added to the horrors of war the even more effective method of famine (Fig. 6). He who surveys the Old World, whether he look at Europe, Asia, or Africa, will see dominating the entire

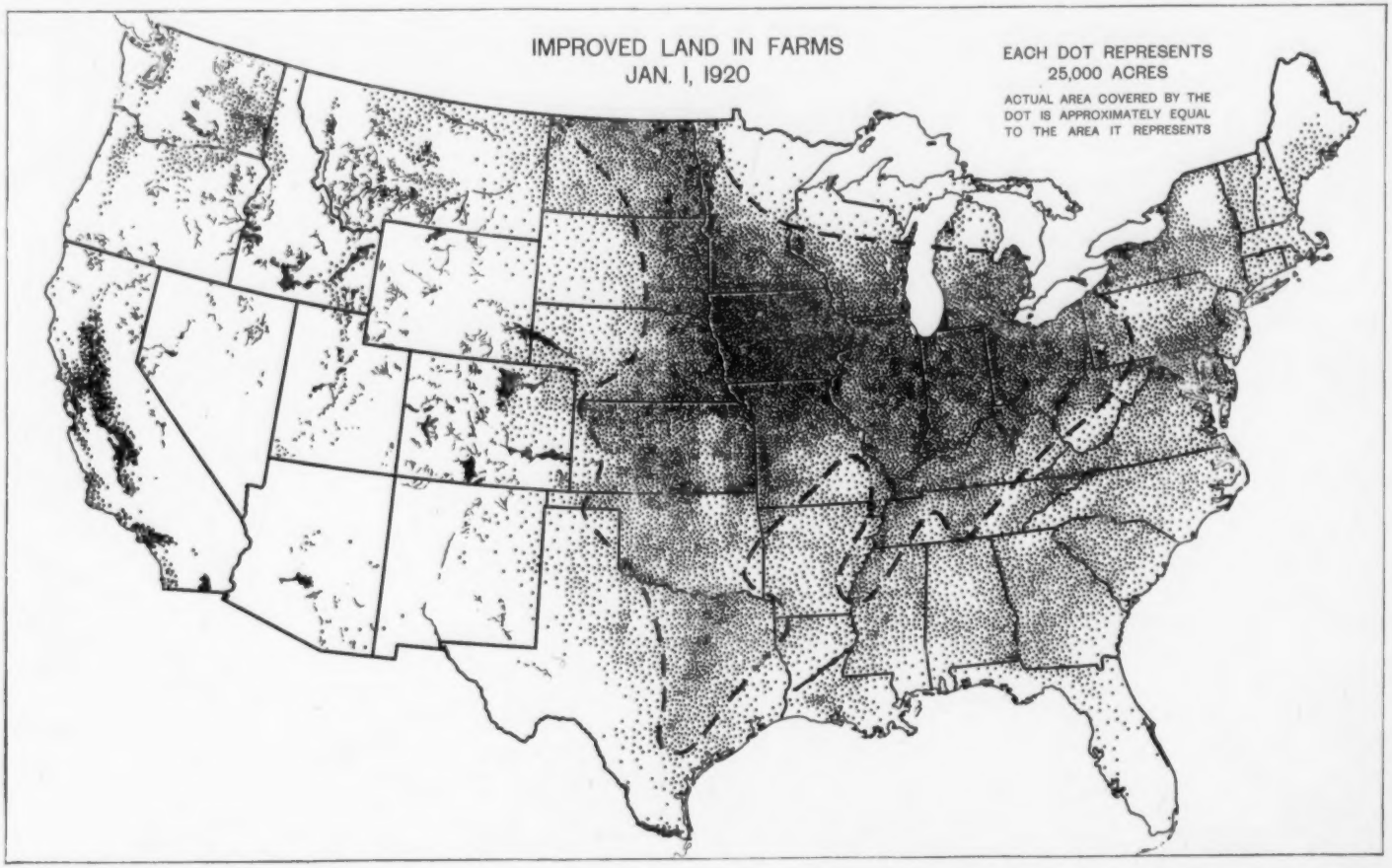

FIG. 7—Improved land in the United States now amounts to a little over one-fourth of the total land area (compare Table I). Four-fifths of it is in the humid eastern half of the United States, and three-fifths is concentrated in the triangular-shaped area indicated by the heavy broken line. In this area 60 per cent of the land area is improved farm land, whereas in the United States outside this area only 15 per cent is improved. Note the irrigated land in the West and compare with Table III.

TABLE I—IMPROVED LAND IN FARMS AND LAND IN HARVESTED CROPS, 1919–20

STATE	IMPROVED LAND		LAND IN HARVESTED CROPS	
	ACRES	PER CENT	ACRES	PER CENT
Tex.	31,227,503	18.6	25,534,195	15.2
Kan.	30,600,760	58.5	22,843,587	43.6
Ia.	28,606,951	80.4	21,609,534	60.7
Ill.	27,294,533	76.1	21,462,852	59.9
Mo.	24,832,966	56.5	16,810,354	38.2
N. Dak.	24,563,178	54.7	19,760,741	44.0
Neb.	23,109,624	47.0	19,432,145	39.5
Minn.	21,481,710	41.5	17,149,813	33.1
Ohio	18,542,353	71.1	13,934,239	53.4
S. Dak.	18,199,250	37.0	15,313,006	31.1
Okla.	18,125,321	40.8	15,393,796	34.7
Ind.	16,680,212	72.3	13,223,256	57.3
Ky.	13,975,746	54.3	7,532,641	29.3
N. Y.	13,158,781	43.1	8,904,768	29.2
Ga.	13,055,209	34.7	12,537,645	33.4
Mich.	12,925,521	35.1	10,000,611	27.2
Wis.	12,452,216	35.2	10,265,998	29.0
Cal.	11,878,339	11.9	6,850,805	6.9
Pa.	11,847,719	41.3	8,999,116	31.4
Tenn.	11,185,302	41.9	7,430,888	27.9
Mont.	11,007,278	11.8	3,924,337	4.2
Ala.	9,893,407	30.1	8,091,496	24.7
Va.	9,460,492	36.7	5,819,414	22.6
Miss.	9,325,677	31.4	6,603,052	22.3
Ark.	9,210,556	27.4	6,839,300	20.3
N. C.	8,198,409	26.3	6,625,009	21.2
Colo.	7,744,757	11.7	5,416,712	8.2
Wash.	7,129,343	16.7	4,251,170	9.9
S. C.	6,184,159	31.7	5,852,376	30.0
La.	5,626,226	19.4	4,022,658	13.8
W. Va.	5,520,308	35.9	2,295,905	14.9
Ore.	4,913,851	8.0	2,993,388	4.9
Ida.	4,511,680	8.5	2,797,943	5.2
Md.	3,136,728	49.3	2,303,282	36.2
Fla.	2,297,271	6.5	1,829,864	5.2
Wyo.	2,102,005	3.4	1,210,250	1.9
Me.	1,977,329	10.3	1,650,189	8.6
N. Mex.	1,717,224	2.2	1,197,752	1.5
Utah	1,715,380	3.3	1,071,160	2.0
Vt.	1,691,595	29.0	1,192,876	20.4
N. J.	1,555,607	32.4	1,162,480	24.2
Mass.	908,834	17.7	664,043	12.9
Ariz.	712,803	1.0	471,345	.6
N. H.	702,902	12.2	548,124	9.5
Conn.	701,086	22.7	519,521	16.8
Del.	653,052	51.9	616,865	49.1
Nev.	594,741	.8	392,520	.6
R. I.	132,855	19.5	76,197	11.2
Total	503,073,007	26.4	375,431,734	19.7

FIG. 7—Improved land in the United States now amounts to a little over one-fourth of the total land area (compare Table 1). Four-fifths of the land area is in the United States, and three-fifths is concentrated in the triangular-shaped area indicated by the heavy broken line. In this area 60 per cent of the land area is improved farm land, whereas in the United States outside this area only 15 per cent is improved. Note the irrigated land in the West and compare with Table III.

economic and social situation this great problem of food supply and of efficient utilization of the land.[1]

Agricultural Maturity in the United States

Now the New World, especially the United States, is attaining maturity. We have extended the area of our cultivated land as far as economic conditions justify (Fig. 7 and Table I). We have nearly cleaned up the original 800 million acres of virgin timber (16 per cent only remains in virgin forest and 30 per cent in second growth) and are confronted with the necessity of growing a new supply. How are we to feed, clothe, and house the oncoming millions? Shall we follow in the footsteps of France and limit our population? or shall we emulate England, encourage industry, and depend in large measure upon foreign lands for our food and raw materials? or shall we endeavor to remain a self-sufficing nation, as Germany tried to become, and embark upon a national policy of land reclamation and fertilization? Apparently the people of the United States are essaying, unconsciously in large measure, all three solutions of the problem. The birth rate is declining, notably and dangerously among the middle and upper classes; industry has increased rapidly, so that since the war our exports of manufactured products have equaled in value those from Great Britain; and we have also, in the Reclamation Act of 1902, established a precedent for federal subsidy in expanding the agricultural area, while in the Muscle Shoals project it appears likely that similar encouragement will be extended in the manufacture of fertilizer. The justification of the Reclamation Act, if such is needed, and of the Muscle Shoals decision, when it is made, is to be found, not in the balance sheet of profit and loss, but in promotion of the public welfare. Such subsidies were incompatible with the classical political economy of England and were not given; but the United States, like Germany, has long afforded both her agricultural and industrial inter-

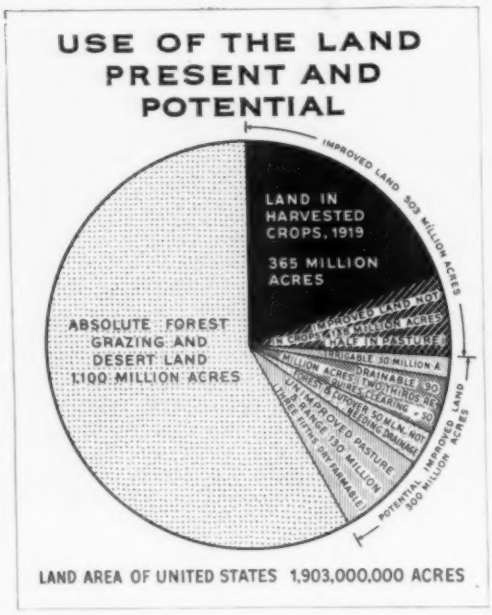
USE OF THE LAND
PRESENT AND
POTENTIAL
IMPROVED LAND 503 MILLION ACRES
LAND IN HARVESTED CROPS, 1919
365 MILLION ACRES
ABSOLUTE FOREST GRAZING AND DESERT LAND 1,100 MILLION ACRES
POTENTIAL IMPROVED LAND 500 MILLION ACRES
LAND AREA OF UNITED STATES 1,903,000,000 ACRES

Fig. 8

[1] Cf. the article by Raymond Pearl: The Population Problem, *Geogr. Rev.*, Vol. 12, 1922, pp. 636–645.

ests the protection of a high tariff. This protection, and possibly direct financial assistance, such as that afforded by the Reclamation Act, may be extended if Congress deems it necessary that we remain a self-sufficing nation and desires to assure the expansion of our agricultural area at a rate sufficient to provide for the increasing population.

Increase in Agricultural Production through Reclamation

We still have about 300 million acres, an amount three-fifths of the present acreage of improved land, which it is possible by various means of amelioration to bring into use for crops. This area, mostly scattered in small tracts in various parts of the United States, consists of about 30 million acres of irrigable land and probably 90 million acres of drainable land, which can be reclaimed when the price of farm products justifies the cost; also there are perhaps 50 million acres of forest and cut-over lands, not requiring drainage but in many cases deficient in fertility, which may be used for crops after clearing; and about 130 million acres of stony or infertile pasture land in the East and potential dry-farming land in the West, the use of which for crops is not justifiable at present prices of agricultural products and labor (Fig. 8).

A national policy with regard to these 300 million acres which could, by expenditure of large sums of money, be made available for crops, is complicated by the consideration that it may be more profitable to increase the productivity of the lands already in use and by the probability that with the return to normal conditions in the Old World, and especially with the development of agriculture in the tropics, certain foods, particularly sugar and the vegetable oils, will be imported from abroad more cheaply than they can be produced at home. The question has been raised whether a reclamation policy must not be fortified by an agricultural tariff policy. It is a pertinent question and one deserving careful study.

But first let us consider whether we can provide from our own lands for the 40 millions more people in 1950, and then for still 40 millions more by the year 2000, with the same amount per capita of agricultural products that are consumed today.

To begin with, our net exports of farm products during the three years since the war have required for their production about one-eighth of our agricultural land. In other words, we are consuming about seven-eighths of our agricultural production; consequently, were our exports to cease we could provide about 125 million people with the same per capita amounts of agricultural products that are consumed at present. Next, with reference to the 30 million acres of irrigable land yet unirrigated, assume that these will be one-third more productive than our improved land is at present. The irrigable area would then be equivalent to 40 million acres of average improved land and would constitute an eight per cent increase upon our 500 million acres of improved land in the year 1920 (Table II). Next, the

drainable land, although it includes large amounts of very fertile land along the Mississippi River, also includes even larger amounts of sandy or peaty soil in Florida and along the South Atlantic coast, and much peat land also in the Lake states, and consequently is unlikely to be more productive than the average of our improved land at present (Fig. 9 and Table III). Ninety million acres is 18 per cent of the 500 million acres of improved land in 1920. The reclamation of most of this land will require co-operative effort. Fully two-thirds of the drainable land will require clearing also.

We come now to the two kinds of land which can be made available for crops by private effort—(1) forest and cut-over land not needing drainage and (2) pasture or grazing land. The forest and cut-over land is mostly poor soil and without heavy fertilization probably would not yield over two-thirds as much per acre as our present improved land. The agricultural production from the 50 million acres of forest and cut-over land would be equivalent, therefore, to that of only 33 million acres of average improved land, or seven per cent of our present acreage. However, in all probability forests will be found to afford a more profitable use for much of this land

TABLE II—IRRIGATED AND IRRIGABLE LAND, 1919 AND 1920*
(*In acres*)

STATE	AREA IRRIGATED 1919	AREA ENTERPRISES CAPABLE OF IRRIGATING	AREA IN ENTERPRISES 1920	TOTAL IRRIGABLE AREA
Cal.	4,219,040	5,894,466	7,805,207	10,000,000
Colo.	3,348,385	3,855,348	5,220,588	5,000,000
Ida.	2,488,806	3,092,810	3,780,048	5,500,000
Mont.	1,681,729	2,753,498	4,329,148	6,000,000
Utah	1,371,651	1,700,550	2,359,244	2,500,000
Wyo.	1,207,982	1,831,039	2,564,668	4,000,000
Ore.	986,162	1,344,046	1,925,987	3,000,000
Tex.	586,120	1,150,542	1,687,447	3,000,000
Nev.	561,447	704,708	1,382,036	1,500,000
N. Mex.	538,377	696,119	961,879	2,000,000
Wash.	529,899	637,151	836,795	3,000,000
Ariz.	467,565	627,303	813,153	1,000,000
La.	454,882	728,742	851,211	.....
Neb.	442,690	562,468	766,768	1,000,000
Ark.	143,946	179,013	246,480	.....
S. Dak.	100,682	150,914	188,382	1,000,000
Kan.	47,312	67,853	102,562	500,000
N. Dak.	12,072	34,235	57,476	1,500,000
Okla.	2,969	9,672	11,742	500,000
U. S.	19,191,716	26,020,477	35,890,821	51,000,000

* Estimates compiled by Dr. R. P. Teele, U. S. Department of Agriculture.

than crops, so that we cannot safely count on increasing our agricultural production more than five per cent by the further clearing of forest and cut-over land not needing drainage (Fig. 10).

Lastly, we have to consider the upland pastures in the East and the potential dry-farming land in the West, perhaps some 130 million acres in all of land that might be used for crops if prices of agricultural products, particularly hay and wheat, were much higher than at present (Fig. 11). The average productivity of this land could not be rated at more than three-fifths that of our present improved land, so that it would be equivalent to only 80 million acres, or 16 per cent of the present improved acreage.

Adding together these estimates of 8 per cent increase in production when all our irrigable land is irrigated, 18 per cent when all the drainable land is drained, 5 per cent when all the forest and cut-over land is cleared

TABLE III—WET, SWAMP, AND OVERFLOWED LANDS IN NEED OF DRAINAGE, 1920*

(*In acres*)

STATE	UNFIT FOR CULTIVATION WITHOUT DRAINAGE	NEEDING COMMUNITY DRAINAGE	STATE	UNFIT FOR CULTIVATION WITHOUT DRAINAGE	NEEDING COMMUNITY DRAINAGE
Ala.	2,664,000	3,227,000	Neb.	91,000	586,000
Ariz.	23,000	41,000	Nev.	53,000	135,000
Ark.	4,220,000	4,881,000	N. H.	119,000	125,000
Cal.	1,179,000	1,861,000	N. J.	52,000	655,000
Colo.	66,000	132,000	N. Mex.	26,000	61,000
Conn.	111,000	127,000	N. Y.	815,000	1,091,000
Del.	188,000	251,000	N. C.	5,390,000	5,886,000
Fla.	16,846,000	16,914,000	N. Dak.	137,000	953,000
Ga.	6,876,000	7,431,000	Ohio	269,000	650,000
Ida.	97,000	141,000	Okla.	650,000	952,000
Ill.	600,000	2,340,000	Ore.	650,000	2,790,000
Ind.	778,000	1,308,000	Pa.	300,000	398,000
Ia.	368,000	919,000	R. I.	33,000	33,000
Kan.	280,000	1,007,000	S. C.	4,589,000	4,898,000
Ky.	555,000	1,337,000	S. Dak.	209,000	619,000
La.	10,431,000	11,468,000	Tenn.	669,000	1,066,000
Me.	1,287,000	1,335,000	Tex.	6,824,000	7,709,000
Md.	499,000	607,000	Utah	145,000	332,000
Mass.	135,000	172,000	Vt.	73,000	88,000
Mich.	5,111,000	5,671,000	Va.	1,038,000	1,496,000
Minn.	5,909,000	6,757,000	Wash.	689,000	908,000
Miss.	4,752,000	5,648,000	W. Va.	74,000	244,000
Mo.	1,085,000	3,017,000	Wis.	4,046,000	5,122,000
Mont.	79,000	120,000	Wyo.	13,000	28,000
			Total	91,543,000	113,537,000

* Estimates compiled by S. J. McCrory, L. A. Jones, F. J. Morschner, U. S. Department of Agriculture.

WET LANDS IN NEED OF DRAINAGE
APPROXIMATE ACREAGE, 1919
EACH DOT REPRESENTS
10,000 ACRES
ACTUAL AREA COVERED BY THE
DOT IS APPROXIMATELY EQUAL
TO THE AREA IT REPRESENTS

FIG. 9

FOREST AND CUT-OVER LAND
SUITABLE FOR CROPS AFTER CLEARING
EACH DOT REPRESENTS
10,000 ACRES
ACTUAL AREA COVERED BY THE
DOT IS APPROXIMATELY EQUAL
TO THE AREA IT REPRESENTS

FIG. 10

FIG. 9—About 90 million acres of land in the United States are unfit for cultivation without drainage. Two-thirds of this land is in the southern states, and one-half of the remainder is in the three Lake states. A large proportion of the wet land in the South is forested and requires both drainage and clearing, but much of the wet land in the Lake states consists of unforested peat bogs.

FIG. 10—The approximate location and extent of forest, cut-over land, and woodland which could be used for the production of crops after clearing. Fully 60 million acres will require drainage also. This map should be considered tentative only. Revised estimates are being compiled, based largely on 1920 census figures.

TABLE IV—AVERAGE YIELD PER ACRE OF CROPS, 1908–13
(Cereals and potatoes in bushels; hay in tons)

	WHEAT	OATS	BARLEY	RYE	POTATOES	HAY
Germany	31.5	54.5	40.8	26.6	201	1.88
United States	14.6	30.2	23.9	15.6	95	1.33

that is likely to prove more profitable for agricultural than for forest use, and 16 per cent for the upland pastures of the East and dry-land pastures of the West that might be used for crops, we have a total of 47 per cent potential increase in agricultural production through reclamation. Forty-seven per cent of 125 million people is nearly 60 million, which added to 125 million amounts to 185 million people. Apparently, therefore, on the basis of these estimates, the arable land of the United States, both present and potential, at its present yields per acre, is capable of providing with food and fibers about 185 millions of people having the same per capita consumption as at present. This is the population which Dr. Pearl estimates will be reached in the year 2000. Whether all this reclaimable land will, by that date, be brought into use for crops is doubtful; it certainly will not unless the prices of agricultural products are much higher than at present.[2]

INCREASE THROUGH MORE INTENSE CULTIVATION

But agricultural production can be increased by growing more food and fiber to the acre as well as by expanding the acreage. Here again, as with population, prophecy is hazardous; but let us assume that our crop yields 50 years hence will be equal to those in Germany before the war, whose soils certainly average no better than ours. Table IV compares the average yield per acre of six leading crops. It is impossible to compare Germany with our country in yield per acre of corn, the great crop which constitutes two-thirds of our total cereal production. It is also difficult to estimate how much the yield per acre of corn might be increased; for, despite the efforts of all our agencies for the promotion of agriculture, the average yield per acre of corn has not increased appreciably since the Civil War. Cotton is in a similar case, owing in part to the ravages of the boll weevil. Let us, therefore, assume that the yields per acre of the principal crops, except corn and cotton, will increase in the United States to equal those in Germany before the war but that the yields per acre of corn and cotton will remain constant. On this basis we may expect an increase in agricultural production of about 33 per cent. This increase in yield applied to our present arable acreage would provide a quantity of agricultural products sufficient for

[2] Purchasing-power price is meant throughout this article, except where otherwise noted.

166 millions of people, and, applied to both our present and potential acreage of arable land, it would provide enough for 250 millions.

Increase through the Use of Improved Pasture for Crops

There is still another factor in this problem requiring consideration. We had in 1910, according to the census, about 84 million acres of improved pasture, but there is probably not over 75 million acres today (Fig. 12). Suppose this improved pasture land were used for crops, how much would production be increased? Here we must venture the boldest guess of all and assume that the use of this pasture land for crops would double its productivity; that is we should have a net increase equal to 37 million acres of crop land. This would be almost exactly a ten per cent increase upon our present acreage of harvested crops. We may estimate, therefore, that by merely using our improved pasture for crops we could secure an agricultural production sufficient for 137 million people without reclaiming any additional land or increasing the yields per acre; by reclaiming our reclaimable land in addition, for 200 million people; or by producing increased yields per acre equal to those in Germany prior to the war, for 183 million. By doing all four things—by ceasing to export agricultural products, by using the improved pasture for crops, by reclaiming all the reclaimable land, and by securing increased yields per acre the agricultural production would be sufficient for 275 millions of people having present standards of consumption.

Increase through Changes in Consumption

Lastly, let us suppose that under the compulsion of increasing prices for certain agricultural products and owing to increasing knowledge of food values, the tastes of our consumers changed—that to a large extent they gave up eating meat and substituted therefor dairy products and various vegetable proteins and oils. Fully three-fifths of the crop acreage in the United States, or about 225 million acres, is used to produce feed for farm animals; and, in addition, our live stock consume the product of about 75 million acres of improved pasture, probably of 150 million acres of unimproved grassland pasture in farms and about 200 million acres of woodland pasture in farms and in our National forests, besides that of perhaps 500 million acres of arid or semiarid open range land in the West. It seems safe to say that the live stock consume two-thirds of the product of the improved land and practically all the product of the unimproved pasture, or fully 80 per cent of the total food and feed produced by tame and wild vegetation in the United States.

But, as horses and mules consume about one-quarter of this total, only about 60 per cent of the food and feed in the United States is used to produce meat, dairy, and poultry products. The food value of the meat and eggs, however, constitutes only 23 per cent, and the food value of the milk and

dairy products about 16 per cent—if calories may be taken as a basis—of the total food consumption of the American people. That is the 20 per cent of the land growing wheat, rye, vegetables, and other crops used directly for human consumption supplies over three-fifths of the food consumed by the American people; while the 60 per cent of the land used to feed meat and milk animals supplies less than two-fifths. The consumption of meat (including lard and poultry) per capita in the United States is now about 170 pounds, whereas in Germany before the war the consumption was about 100 pounds, and in Japan it is only four pounds. The annual per capita consumption of meat in the United States could probably be cut to 50 pounds without injury, if compensated by proportionate increase in use of dairy products and vegetables. Such diet, fully as nutritious as our present partial meat diet, would enable the nation almost to double its population without diminishing its real welfare.

The Limits of Agricultural Production

Briefly, then, our arable land, present and potential, if fertilized and cultivated like the land of Germany, could provide food and fibers in accordance with our present tastes for about 250 million people, and with a largely vegetarian and dairy diet for from 400 to 500 millions, so long as the supply of fertilizer held out. Europe, which is comparable with the United States in area but probably has somewhat greater agricultural resources, had, before the war, a population of about 450 millions. Probably 100 millions of these were fed upon imported food. However, if the lands of Russia produced yields like those of western Europe the continent would have been self-supporting agriculturally.

But it will require more labor per unit of product to cultivate the land so intensively; the price of farm products consequently will be higher, and a larger proportion of the national effort will necessarily be devoted to agriculture. Once we attain a stationary population, however, and need not provide new houses for the increasing population, nor build new roads and railroads, nor irrigate, drain, or clear new land, it may be possible to devote this greater proportion of the nation's labor and capital to agriculture without diminishing the per capita income below the present level. In all probability, however, the standard of living will be much like that in Europe today.

The Present Trend in Land Utilization

After this long flight into the realm of statistical fancy, let us return to solid ground and note the actual trend in land utilization during recent years. The figures now available from the 1920 census show significant changes during the preceding decade. There was an increase for the country as a whole of nearly 77 million acres of land in farms, but of less than 25 million acres of improved land. Land in crops, however, increased 45

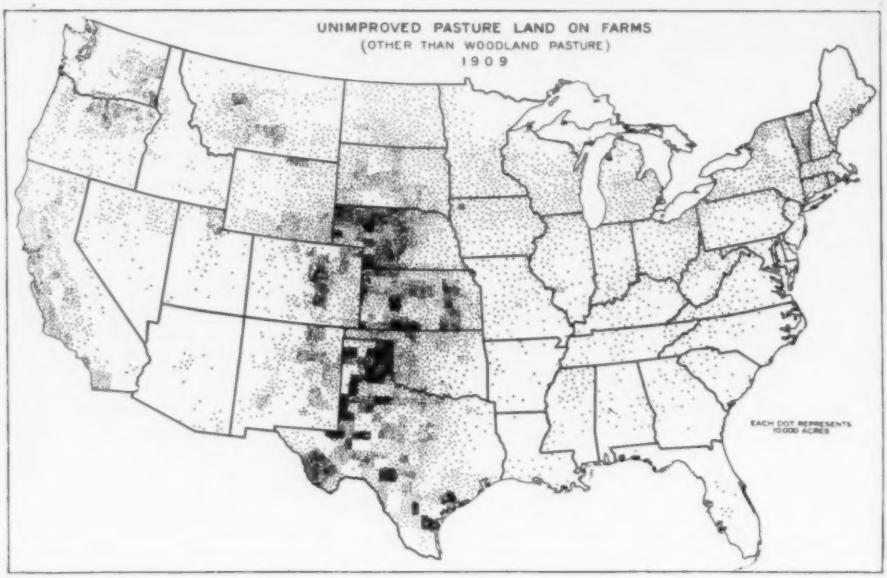

FIG. 11

FIG. 12

FIG. 11—Unimproved pasture in farms (other than woodland pasture) amounted to over 100 million acres in 1909 (statistics for 1919 are not yet available). In the West this unimproved pasture will be fenced in gradually, and much of it called improved pasture. In the East some unimproved pasture has been reverting to forest; but, on the other hand, some poorer quality improved land has been reverting to unimproved pasture.

FIG. 12—This picture, taken in southeastern Montana, shows the kind of unimproved semiarid pasture which is being fenced in and, in its better portions, sometimes put into crops the yield of which is abundant in the occasional wet season. There are 100 million acres of such marginal grassland in the United States on which a speculator may make a modest fortune one season growing wheat and lose it all the next season. (Photograph by J. S. Cotton.)

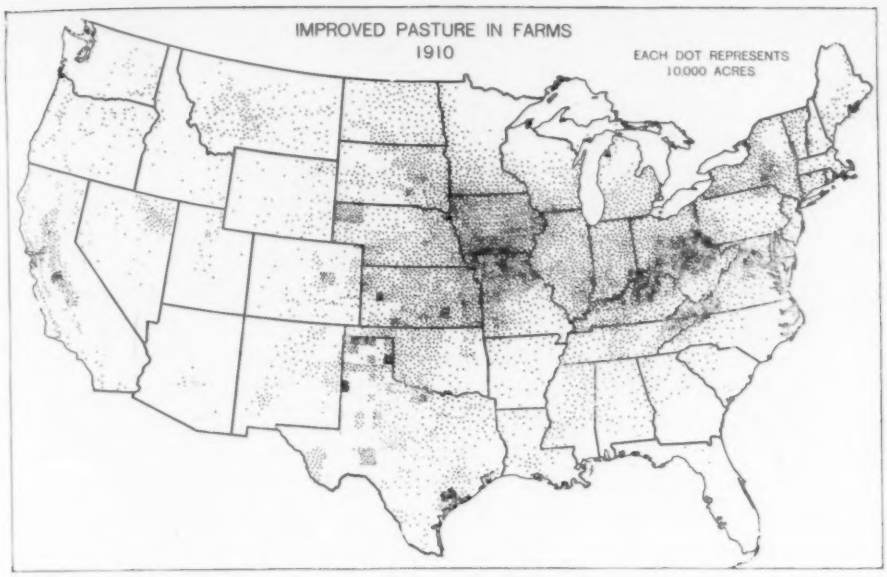

FIG. 13

FIG. 14

FIG. 13—There were 85 million acres of improved pasture land in the United States in 1909; but, owing to the plowing up of some of this pasture for crops, probably not over 75 million acres remain today. The large acreage in the Ohio River valley and in the corn belt is noteworthy.

FIG. 14—Rich limestone land in the Valley of Virginia (Tazewell County) which is kept in pasture because, were it used for crops, the soil would rapidly wash away. Where the slopes become very steep along the mountain ridge in the background the land is kept in forest. In general, land having over 15 feet fall in 100 should not be used for crops, and that having over 25 feet should be used for forest. (Photograph by J. S. Cotton.)

million acres. In other words, there was a large increase of unimproved land in farms and of area in crops, and probably a large decrease in improved pasture and other improved land not in crops. Patriotic motives, supported by the high prices paid for farm products during the war and for some time afterward, evidently caused the plowing up and planting to crops of much improved pasture.

Since 1919, with lowering prices of farm products, much of this crop land has returned to pasture; and probably more will be seeded down during the next few years. But this increase of crop land during the war, largely at the expense of improved pasture land, is indicative of what is likely to happen again when rising prices stimulate increased production. It suggests that the demands of our growing population are likely to be met by more intensive use of the better land rather than by the extension of crop production onto the poorer lands.

The cultivation of this greatly increased acreage of crops was accomplished by an apparently decreased number of farmers and farm laborers. The number of persons engaged in agriculture decreased, according to the census, from 12,386,000 in 1910 to 10,659,000 in 1920.[3] This cultivation of 14 per cent more crop land by 14 per cent fewer farmers and laborers, without diminution in yield per acre, can be fully explained only by greater use of machinery, of fertilizer, and other forms of capital. The nominal value of implements and machinery on farms increased nearly three-fold between 1910 and 1920, or, allowing for increased prices, the farmers in 1920 were using machinery having about 50 per cent more real value than in 1910. The quantity of fertilizer used in 1919 was 40 per cent greater than in 1909. This notable increase in efficiency of the American farmer suggests that increased production, for the present at least, will be achieved by the greater use of capital rather than of labor. American agriculture shows no tendency as yet to degenerate into a peasant type of farming.

Geographical Distribution of Changes in the Use of Land

This trend in land utilization becomes of greater significance when considered geographically. Dividing the United States into a humid eastern and a largely arid or semiarid western half by a line passing through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas, about midway of the belt in which crops give place to grazing as the major means of agricultural production, we find that the increase of land in farms was practically confined to the western portion of the country (Fig. 15). The eastern states show a notable and widespread decrease in farm land between 1910 and 1920, except in the northern portions of Michigan, Wisconsin, and Minnesota, which have been undergoing settlement, the Ozark section

[3] However, as the 1920 census was taken January 1 and the 1910 census was taken April 15, it appears likely that a large number of farm laborers were missed or assigned to other occupations by the enumerators in 1920. Making allowance for this discrepancy, it seems certain that the acres of crops per person engaged in agriculture increased at least one-sixth between 1909 and 1919, and the production per person even more.

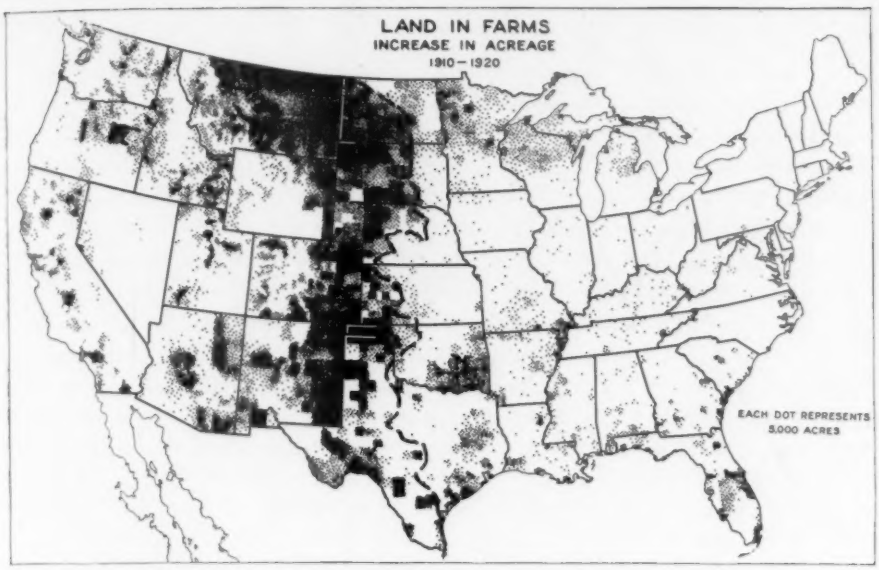

FIG. 15

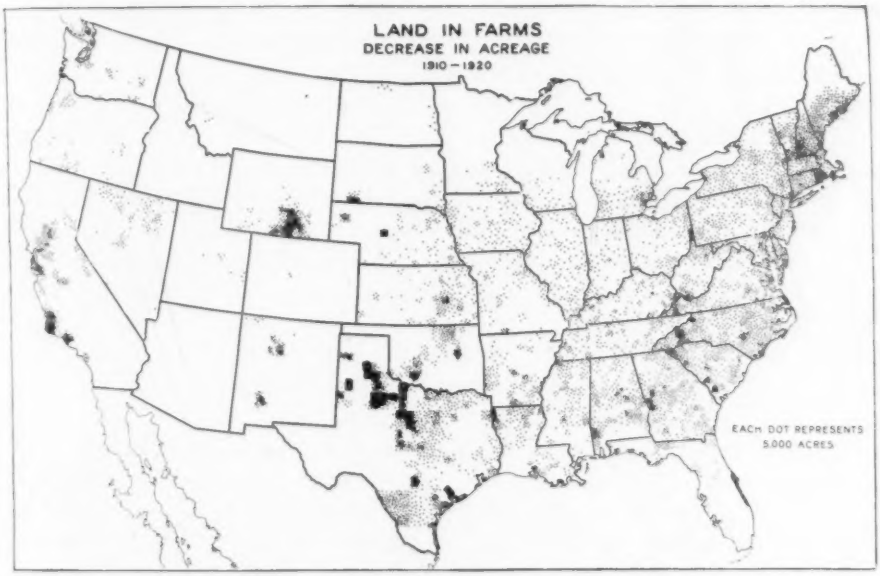

FIG. 16

FIG. 15—The notably great increase in acreage of land in farms in the Great Plains region and far western states was owing principally to the enactment of the Enlarged Homestead Act in 1909 and the Grazing Homestead Act in 1916, which authorized entry on 320 and 640 acres of land, respectively. The dashed line is drawn along the eastern margin of the Great Plains region, where grazing gives place to crops as the major means of agricultural production.

FIG. 16—The decreases in acreage of land in farms shown in Texas are mostly nominal rather than real, being due to shifts from one county to another of the headquarters of large cattle ranches. The decrease in the South is owing largely to the inclusion of less forest land within the farm boundaries in 1920 than in 1910. In New England it is due partly to this cause and partly to the reversion of some pasture land to forest.

of Missouri, which is still in process of agricultural development, and several counties in Arkansas and Florida where large areas of land have been reclaimed by drainage or clearing (Fig. 16). A number of counties in those portions of the Dakotas, Oklahoma, and Texas included within this eastern division also showed an increase of farm land. The aggregate decrease of farm land in the eastern portion of the country amounted to seven million acres, while the increase in the western portion was 84 million acres.

Both the decrease of farm land in the East and the increase in the West, however, were more nominal than real. In the southeastern states the decreased area of farm land is almost wholly accounted for by the decreased area of woodland in farms, not due to clearing but to including less of the adjacent forest within the farm boundaries. In the corn belt a small portion of the decrease in farm land can be attributed to the growth of cities and villages, but the major portion of the decrease indicated is inexplicable on any other basis than incompleteness of enumeration. In New England, New York, Pennsylvania, Maryland, and Virginia, on the other hand, there has occurred, undoubtedly, a real and notable decrease in the extent of the arable area.

In the western half of the nation the enormous increase in area of farm land is accounted for very largely by the enactment of the Enlarged Homestead Law in 1909 and the Grazing Homestead Law in 1916, which encouraged thousands of young men to apply for half-sections and sections of public land that was being used by adjacent ranchmen for grazing cattle and sheep. Most of this land fortunately has been permitted by the homesteaders to remain in wild grass, as is indicated by the fact that of the reported increase of 84 million acres of farm land in this western half of the nation 60 million acres were unimproved. Transformation of this western range into so-called farm land, in other words, has not involved much increase in intensity of its utilization; in fact, in many localities it has decreased agricultural production. On non-irrigated farms and ranches in the western states there were, apparently, about the same number of live stock in 1920 as in 1910.

A much better criterion of changes in the extent of arable land than the statistics of land in farms is to be found in the figures of crop land (Table I). The acreage of land in crops, wholly unlike farm land, shows a remarkably large and universal increase between 1910 and 1920 (Fig. 17). Only 500 counties out of 3066 in the United States show a decrease in crop acreage during the decade (Fig. 18). This decrease was practically confined to New England, eastern New York, and northern New Jersey; to several counties in central Illinois and in central Alabama and the silty uplands of Mississippi, also in southern Louisiana and southeastern Texas; to the Flint Hills district of Kansas and the adjacent portion of Oklahoma; and to the Sierra and the San Francisco Bay and adjacent coast counties in California. The increase in acreage was notable in western Ohio and northern Indiana, in the lower Coastal Plain of Georgia and Alabama, and along the

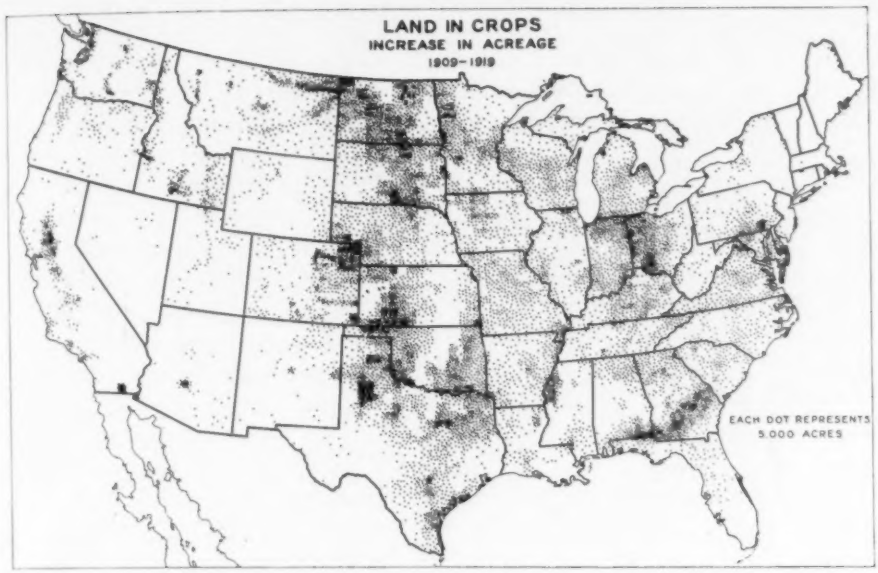

FIG. 17

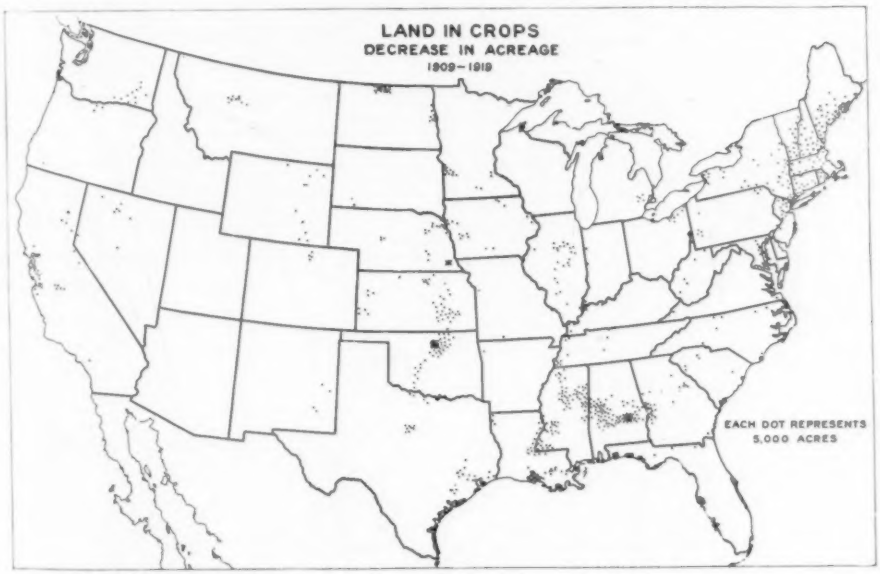

FIG. 18

FIG. 17—The acreage of land in crops, wholly unlike farm land, shows a remarkably large and almost universal increase between 1910 and 1920, amounting to nearly 50 million acres. Patriotic motives, supported by the high prices paid for farm products during the war and for some time afterward, caused the plowing up and planting to crops of much improved pasture.

FIG. 18—The decrease in acreage of land in crops between 1910 and 1920 was practically confined to New England, eastern New York, and northern New Jersey; to the fertility-depleted Black Prairie belt of Alabama and Mississippi and the silty uplands in the southwestern corner of that state, in several counties in Louisiana, and in southeastern Texas; and to the Flint Hills of Kansas and the adjacent section of Oklahoma.

Great Plains border from Montana to Texas. The net increase in crop land in the eastern half of the United States amounted to nearly 30 million acres, and in the western half to about 20 million acres.

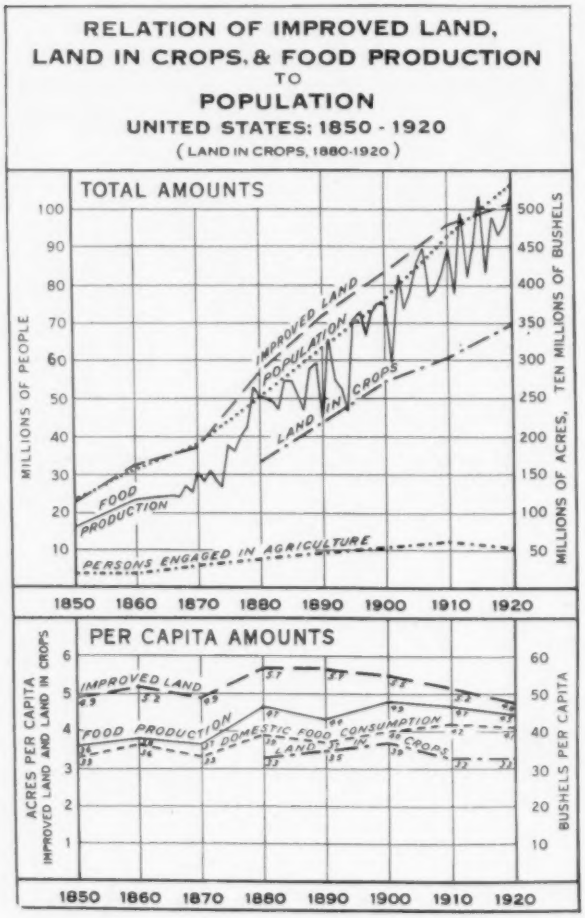
RELATION OF IMPROVED LAND, LAND IN CROPS, & FOOD PRODUCTION TO POPULATION
UNITED STATES: 1850 - 1920
(LAND IN CROPS, 1880-1920)
TOTAL AMOUNTS
MILLIONS OF PEOPLE
TEN MILLIONS OF BUSHELS
MILLIONS OF ACRES,
IMPROVED LAND
POPULATION
LAND IN CROPS
FOOD PRODUCTION
PERSONS ENGAGED IN AGRICULTURE
1850 1860 1870 1880 1890 1900 1910 1920
PER CAPITA AMOUNTS
ACRES PER CAPITA
IMPROVED LAND AND LAND IN CROPS
BUSHELS PER CAPITA
IMPROVED LAND
FOOD PRODUCTION
DOMESTIC FOOD CONSUMPTION
LAND IN CROPS
1850 1860 1870 1880 1890 1900 1910 1920

FIG. 19—Food production increased more rapidly than population till about 1906, since when it has increased more slowly than population. Consumption per capita has been maintained up to the present time by diminishing the exports. The per capita production and consumption figures are 5-year averages centered on the census year.

The trend in land utilization during the decade clearly has been toward the more intensive utilization of the more fertile, level, or favorably located land, that is its use for crops rather than for pasture; and toward the less intensive utilization of the less fertile or less favorably situated land, that is its use for unimproved pasture or forest. Despite the high prices of agricultural products, which still continued in 1919 when the census was taken, much improved land of poor quality in the eastern half of the United States had been allowed to revert to unimproved pasture, and much unimproved pasture to forest; while at the same time the better pasture land was plowed up and put into crops. In the West likewise, outside the Great Plains region, the increase in irrigated land was about equal to the entire increase of improved land, indicating no extension, on the whole, of the area of dry-land farming. The situation in the Great Plains region is too uncertain, as yet, to permit a definite statement.

THE TREND IN AGRICULTURAL PRODUCTION

There has been no diminution of production, however, because of this concentration of labor on the more fertile or favorably located land, but

instead an increase, not only per person engaged in agriculture but also in total product of the area or region. In New England, for instance, where this trend in land utilization has been notable, the acreage of hay, which constitutes over 80 per cent of the acreage of all crops, has constantly decreased since 1879, while the production of hay has almost as constantly increased and was greater in 1919 than in any previous census year. In 1879 the average yield per acre was less than one ton, whereas in 1919 it had increased to 1.13 tons of hay and 1.48 tons of hay and forage combined.

For the United States as a whole the increases in the average yields per acre of the more important crops during the decade 1911 to 1920 as compared with the decade 1866 to 1875 were: corn, 0.3 bushel (1 per cent); wheat, 2.7 bushels (23 per cent); oats, 4.1 bushels (14 per cent); barley, 2.4 bushels (10 per cent); potatoes, 3.0 bushels (3 per cent); rye, 1.8 bushels (14 per cent); hay, .05 ton (4 per cent); cotton, 1 pound (1 per cent). Considering food alone, as indicated by the total production of corn, wheat, rye, oats, barley, rice, buckwheat, Irish potatoes, sweet potatoes, and sugar, expressed in units approximately equivalent to a bushel of wheat, the per capita production for the total population was for the year 1849, 36 bushels; for 1859, 38 bushels; the average for 1866–75, 37 bushels; for 1876–85, 47 bushels; for 1886–95, 44 bushels; for 1896–1905, 49 bushels; for 1906–15, 47 bushels; and for 1916–20, 45 bushels.

It is interesting to compare these figures of production per capita with those of improved land per capita. In 1850 there were 4.9 acres of improved land per person in the United States; in 1860, 5.2 acres; in 1870, 4.9 acres; in 1880, 5.7 acres; in 1890, 5.7 acres; in 1900, 5.5 acres; in 1910, 5.2 acres; and in 1920, 4.8 acres. The maximum acreage of improved land per capita was reached about 1885; the maximum production per capita of food, about 1905 or 1906, or 20 years later. Apparently we have reached that stage in our agricultural development when neither increasing acreage nor increasing yield per acre is able to maintain production per capita (Fig. 19).

Means of Increasing the Supply of Agricultural Products

Heretofore, the supply of agricultural products in the United States has been increased mainly by extension of the arable area and by improvements in agricultural technique. Hereafter, it appears probable, it will be increased by at least five other methods, i.e. by greater intensity of cultivation, by diminishing waste, by reducing our exports, by increasing our imports, and by gradual shifting from a diet in which meat figures prominently to one largely confined to the cereals, vegetables, and dairy products. The greater intensity of cultivation is already indicated by the increasing proportion of farm land devoted to crops; the increasing proportion of crop land devoted to vegetables, tobacco, and other intensively cultivated crops; and the increasing yield per acre of most of the crops. Diminished waste in transportation and marketing is being attained by refrigerator cars,

cold-storage facilities, utilization of by-products, especially in the meat-packing industry, and by orderly marketing. Our net exports of foods have been reduced from about 17 per cent of our production during the decade 1896–1905 to about 12 per cent during the five years 1916–1920. For the five years prior to the war the net exports of food products constituted only 5 per cent of the production. That the change in diet is already in progress is indicated by a beef consumption per capita only three-quarters as great now as it was 15 years ago.

Importation of Agricultural Products

The most important factor, in my opinion, to be evaluated in considering a national policy of land utilization is that of the competition in our markets of agricultural products from foreign countries, particularly from the tropics. Although there is in Siberia a vast expanse of undeveloped arable land, probably as great in amount as the total arable land of the United States, both improved and unimproved; and although there are considerable areas of fertile land as yet undeveloped in Argentina, Australia, and other countries of temperate climate, nevertheless, the great reservoir of unutilized agricultural resources is to be found in the tropics. Tropical and subtropical countries include approximately half of the arable land, present and potential, of the world. Of the arable land in these countries less than one-fourth (about 1200 million acres) is in cultivation at present, and possibly one-eighth is used for pasture; whereas in the temperate zones fully one-half of the ultimately arable land is now in crops, and almost another third is used for pasture. Apparently the tropics and subtropics include about three times as large an area of potentially arable land as that which remains undeveloped in the temperate zones. Most of this land in the tropics is cheap; and, although the task of clearing or reclaiming is quite generally more or less difficult, labor is much cheaper in tropical countries than in the United States.

The competition in our markets of the products of this cheap land and labor appears likely to become increasingly serious for the American farmer. For several years the production of sugar in tropical lands has exceeded that in the temperate zones, and it may be questioned whether without the protection afforded by the tariff the sugar growing industry in the United States would be able to maintain itself. In recent years the manufacture of vegetable oils from tropical nuts and seeds likewise has developed rapidly and is already affecting the demand for lard, butter, and other animal fats. It seems likely that our increasing demand for agricultural products, consequent upon an increasing population, will be supplied in increasing proportion by imports from foreign lands, especially the tropics, unless the nation decides to maintain a policy of tariff protection.

The importation of agricultural products is further favored by the extraordinary purchasing power the people of the United States have

attained, particularly since the World War. The favorable rate of exchange facilitates our purchase of commodities in foreign countries at the same time that it places an obstacle in the way of foreign purchasers buying from us. So favorable a rate of exchange is, of course, temporary; but the vast accumulation of capital in this country which must in part seek investment in foreign countries will encourage in increasing extent the importation of agricultural products as payment of dividends on these foreign investments.

TABLE V—ARABLE LAND OF THE EARTH

Tropical and subtropical zones		
Total land area	23,000,000	sq. miles
Land too arid for crops	8,000,000	" "
Land with adequate rainfall	15,000,000	" "
Probably one-third ultimately arable	5,000,000	" "
Cultivated at present	1,200,000	" "
Arable land in pasture	600,000	" "
Potentially arable not used for crops or pasture	3,200,000	" "
Temperate zones		
Total land area	29,000,000	" "
Land too dry for crops	7,600,000	" "
Land too cold for crops	6,400,000	" "
Land with adequate rainfall and heat	15,000,000	" "
Probably one-third ultimately arable	5,000,000	" "
Cultivated at present	2,500,000	" "
Arable land in pasture	1,500,000	" "
Potentially arable not used for crops or pasture	1,000,000	" "

Those who seek to stimulate expansion of the agricultural area in the United States by bringing into use for crops land of poorer quality or land which requires heavy expense for drainage or irrigation, must reckon with this competition from the cheaper land and labor of foreign countries and with the fact that those countries must pay for the use of American capital largely with agricultural products.

NATIONAL WELFARE THE BASIS OF A NATIONAL LAND POLICY

Whether it is desirable to afford protection to our agriculture in order to promote its expansion involves many questions of policy both economic and social. If after mature discussion it appears advisable to embark upon a policy of protection for our agricultural industries, it is important that the expansion of the agricultural area be promoted in accordance with broad plans of national scope, based on the principle of national welfare. The obstacles to be overcome in the reclamation by drainage, irrigation, or otherwise, of the lands that remain unused will increase in difficulty and magnitude as the more feasible projects are completed and will inevitably require in increasing extent the resources and credit of the government.

Before such costly public works are undertaken, it is important that the rate, the time, and the direction of expansion of our arable area be carefully studied.[4] The rate of expansion should depend upon the rate of increase of population and the trend of per-capita consumption, of per-acre production, and of exports and imports. The time for expansion should be determined with reference to construction costs and the financial situation. The direction of expansion should involve thorough investigation of soil and climate, with especial reference to crop adaptation and farm organization. A classification of the land of the United States with reference both to physical character and to economic use is basic to an orderly expansion of our arable area. Classification with reference to physical character is being well made by the Soil Survey; but classification with reference to economic use has been made only for small areas and usually incidental to other objects. A survey of the present and potential use of the land is one of our greatest national needs. This survey must include a study of the agricultural resources of foreign countries also, especially of the tropics, whose products are likely to invade our markets in increasing amounts unless excluded by tariff barriers.

In conclusion, it appears appropriate to note again that, although the land resources of the United States make it possible to feed and clothe 400 million people in a manner that will not seriously impair their health and activity, it will probably require a larger proportion of the national effort to do so than is required at present, and there will be less of other commodities, especially the luxuries, available per individual for consumption. The production per capita of agricultural products apparently reached its crest about 1906–07 and is now diminishing. The production per capita of manufactured products is probably still increasing; but, as manufacturing is dependent largely for its raw materials upon agriculture and forestry, manufactured products must soon show also a diminishing production per capita unless there be extensive importation of food and raw materials from abroad. In other words, our nation is probably near, possibly past, the crest of greatest average income per capita; and every increment in population is likely to increase the complaint of the high cost of living.

[4] See L. C. Gray: Helping Landless Farmers to Own Farms, *Yearbook Dept. of Agric. for 1920*, pp. 271–288.

NATIVE LIFE IN FRENCH NORTH AFRICA*

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The country bordering the Mediterranean Sea on the south between Tunis and the Atlantic Ocean has no name of its own, at least none in common use. It is known to some as Africa Minor; as it is almost entirely under French control we may call it French North Africa.

It is a long stretch of territory, about 1,200 miles from east to west and 200 miles from north to south. The three countries that compose it—Tunisia, Algeria, and Morocco—form practically one great geographical unit, the Atlas Mountains. The census of 1921 gives the native population in Tunisia and Algeria as 2,000,000 and 5,000,000 respectively. The total amount, Morocco included, may be placed at between 11,000,000 and 12,000,000.[1] The whole of this population is Mohammedan, with the single exception of the Jews; and even these use no other native language than Arabic. For this reason we might borrow from the Arabic the native name for the country, *Maghrab*, as it is known throughout the Mussulman community. True, the name covers not only Africa Minor but Tripoli and the Sahara as well; in fact everything west of Egypt. Maghrab is the western half of the Mohammedan world; the other, the eastern half, being the *Sharq*.

Egypt, the seat of the most ancient and best-known eastern empire, is the most typical part of the Sharq: but Mesopotamia as well, and Palestine, Syria, Persia, Arabia—every province of the Sharq looks back upon a glorious historical past. Sharq is the cradle of the world's civilization, at least of western civilization. Not so Maghrab. Its people are warlike; in fact, war has been one of their greatest achievements. They conquered southern Spain, Sicily, and Egypt, though not on their own account: they have always been under foreign masters. The early dawn of history shows Carthage, a foreign colony of Tyrian settlers, ruling Africa Minor. Later, North Africa was for centuries a province in the Roman empire. Then came the Vandals—a wandering Germanic tribe; then the Byzantines; then the Arabs; then the Turks, whom the French expelled ninety years ago. For it is to be noted that never did any foreign master in Maghrab yield to the pressure of native insurgents. Every one of them has been overthrown and succeeded by another foreign invader.

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* Read at the Joint Meeting of the Association of American Geographers and the American Geographical Society, April, 1922.

[1] Augustin Bernard: Le recensement de 1921 dans l'Afrique du nord, *Ann. de Géogr.*, Vol. 31, 1922, pp. 52–58—abstracted elsewhere in this number of the *Review*.

The Distribution of Languages[2]

The North African native languages are only two: Arabic, the language of those who amongst the various foreign invaders introduced Mohammedanism into the country, and Berber, a language which has been at home in the Barbary States from the beginning of history. The native subjects of Carthage and Rome must have spoken a language closely connected with Berber, as is shown by the "Libyan" inscriptions found on tombstones, sometimes with Latin translations; more often on bare rocks, when they occasionally appear associated with very old clumsy drawings of animals, some of them now extinct. The Libyan alphabet is still in use in remote parts of North Africa amongst the Saharan Tuaregs.

Both as a spoken and written language Berber is still in a state of infancy. It is a set of poor disconnected dialects, without grammar or fixed vocabulary; and writing has never been developed further than the rock-engraving stage. The language is on the same level as the people. Like everything Berber, it does not develop; nor, on the other hand, does it disappear and die.

Arabic, of course, compares very favorably with Berber. It is a developed language, fit for administrative, commercial, and literary purposes, at least to a certain extent. And yet after a 1200-year struggle it has not superseded Berber. In Algeria we know definitely the exact number of Berber-speaking natives; they amount to about one-third of the total population. In Morocco, as far as we know, the proportion is reversed. Probably it is not far from the truth to say that in French North Africa one-half of the natives speak Berber, and, though Mohammedan, they know very little or nothing at all about the holy language of the Koran.

A difference of languages is always a serious matter; it is particularly so in this case. A glance at the map shows the puzzling way in which the two peoples and the two languages confront each other. The two domains are interwoven in the most confused way, Arabs and Berbers are scattered in disconnected patches. The object of this paper is to review these several patches, each of which is more or less a separate natural region.

Kabylia

Amongst the regions inhabited by Berbers the best known is Kabylia, the tract of high, rugged, and wooded mountains along the coast between Algiers and Constantine. There lives a rather crowded population of Berber-speaking natives, almost wholly ignorant of Arabic. They are peasants and more especially gardeners, tending orchards of fig, olive, and orange trees. They dwell in humble cottages, grouped into moderate-sized villages, each of them ranging from a few hundred to a few thousand inhabitants. They are organized into democratic communities, the power belonging to the *jamā'a*, a body somewhat similar to a town council. Accord-

[2] E. F. Gautier: Répartition de la langue berbère en Algéria, *Ann. de Géogr.*, Vol. 22, 1913, pp. 255–266.

ing to Masqueray[3] those rural democracies seem closely related to the old Italian communities eight centuries before Christ, at the time when Rome was only a small city amongst many others.

The word Kabylia comes from the Arabic and means tribes, or clans, indicating an organization of democratic character which to the Arabic mind is always puzzling. Anthropologists agree that Berbers, in bodily structure and the shape of their skull, are connected with southern Italians and southern Spaniards rather than with African and Oriental races. On the other hand, though the name Kabylia may be new, the people themselves

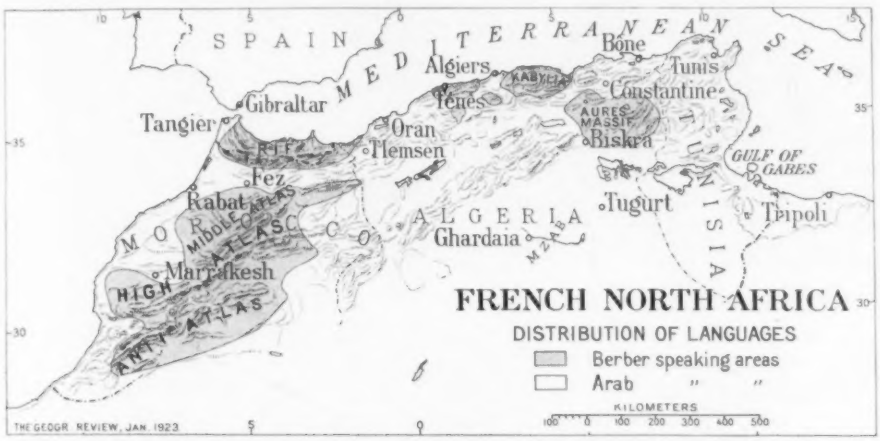

FIG. 1—Sketch map showing in generalized form the distribution of Arabic- and Berber-speaking peoples of French North Africa. Scale approximately 1:21,500,000.

are very old. They are the "Mauri" of the Latin historians. Kabylia is nothing else than the ancient "Mauretania."[4]

SHAWIYA

Southeast of Kabylia are the Aures Mountains where live Berber-speaking tribes which bear the name of Shawiya. Aures proper is a peculiar little world of high, picturesque valleys, shut in amongst very high mountains, the highest in Algeria. Shawiya extends outside the boundaries of Aures along the high plains in the north; but these plains are much broken up and interspersed by many isolated rugged ridges or crests, standing out like so many rocky fortresses.

The Shawiya resemble the Kabyles in many important features; they too are rural democracies governed by *jamā'a*, and their villages are very much like the Kabyle ones, as far as topographical situation is concerned; both occupy impregnable positions crowning the tops of steep hills.

[3] Émile Masqueray: Formation des cités chez les populations sédentaires de l'Algérie, Paris, 1886.
[4] See Stéphane Gsell: L'Algérie dans l'antiquité, Algiers, 1903.

FIG. 2

FIG. 3

FIG. 2—A Kabyle farm. The four exterior walls are windowless, all the rooms opening onto the interior court according to the way of the Mohammedan house. But here in Kabylia, instead of a flat roof is one gabled and tiled very much of the European type.

FIG. 3—A Kabyle village: small tile-roofed houses clustered on a hill top.

FIG. 4

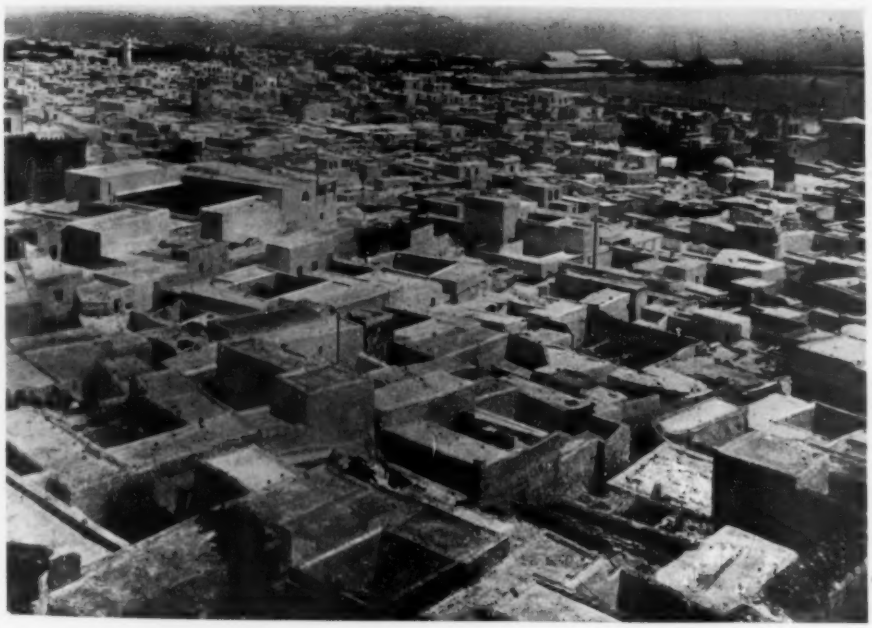

FIG. 5

FIG. 4—The town of Constantine on the border of Kabylia. As seen from above it is much like a European city of the Mediterranean seaboard.

FIG. 5—The city of Susa (Sousse) on the northeastern coast of Tunisia. Note the interior courts of the houses and the whitewashed flat-terraced roofs, the realm of the women.

The great difference between the two peoples is that the Shawiya are shepherds in accord with the nature of their more southern and more arid climate. The name "Shawiya" means shepherd. They drive their sheep along from pasture to pasture and so live much of the time under canvas, their villages remaining more or less empty for a great part of the vear. A prominent feature in the Shawiya architecture is the tribal granary, a common building with many separate cells for the different families to store their corn. Somebody is appointed by the *jamā'a* to look after the stores while the owners are away. In some cases the granary could be trusted to look after itself, being high up on an inaccessible cliff (Fig. 6).

The Shawiya, however, have no connection with their neighbors, the great camel-breeding nomads who cover hundreds of miles from winter to summer pastures. For the Shawiya only shift their dwellings along a radius not exceeding a score of miles or so; from mountain top in summer to low valley and plain in winter, a movement comparable with the well-known *transhumance* as it is practiced in Italy, Spain, and southern France. Still the Shawiyas are nomads after all and have been always. Their country is the ancient Numidia, the root of which is found in the word nomad.

Shawiyas and Kabyles speak such different Berber dialects that they can not readily understand each other. Though neighbors, they belong to two different worlds, as was the case in the past between Numidia and Mauretania. On the northern slope of Aures lies Timgad, the wonderfully preserved remains of a Roman town, almost vying with Italian Pompeii in archeological glory. The whole of the Shawiyan country is scattered over with similar Roman ruins which, on the contrary, are scarce in Mauretania. Modern Kabylia, very much like ancient Mauretania, is of Algerian provinces by far the most impervious to European colonization, largely because of the passionate love of the peasant for the piece of ground he owns. In regions of nomadism like ancient Numidia the ownership of the land by peasantry is unknown, and there is plenty of room for the encroachments of colonization.

Moroccan Berbers

Morocco as a whole has been closed to European investigation except during the last fifteen years; and this is particularly true of the Berber parts of the country, which are very little known. There are two main Berber provinces in Morocco, one extending along the Mediterranean coast from Tangier to the Algerian border—the so-called Rif, the other chiefly occupying the Atlas, more than one-half of Morocco. It is noteworthy that here most of the tribes still call themselves "Beraber" (singular "Berberi")—a name which, while it has been preserved outside North Africa in European languages, has quite disappeared from common use amongst natives in Algeria. The Atlas is the mightiest stronghold of Berber-speaking natives in Africa Minor.

Rif and Atlas Berbers have features in common with Kabyles and Shawiya. They too inhabit high, rugged mountains; and in Morocco as in Algeria they have succeeded through the whole of history in keeping the foreign yoke more or less away from their mountains. Kabylia has been the last achievement of French conquest in Algeria. In Morocco this same French conquest encircles the Atlas and penetrates it but deals with the more secluded parts of it in the slowest and most prudent way.[5] What difficulties Spain meets with in the Rif everybody knows. There is no doubt

FIG. 6—Granary of the Shawiya village of Banyan in southwestern Aures. For safeguarding the stores during the lengthy absence of the seminomadic villagers the granary is placed in an inaccessible position projecting from a cliff top.

that the political organization of the Moroccan Berbers closely resembles that of their Algerian brothers. They are a confusion of petty tribes or clans, democratic communities, every one of them controlled by a *jamā'a*.

Needless to say, there is no kind of general political organization nor anything like a common national feeling among North African Berbers. Rif and Atlas have remained up to now one of the least-explored corners of the globe, because the lack of any central authority and the never-ending feuds between petty tribes have made the country impenetrable.

TUNISIA

The Arabic part of French North Africa seems at first glance rather less disconnected than the Berber sections. Actually, however, this is not the case. The several sections are no more closely linked than the Berber

[5] For stages of French penetration in Morocco see map accompanying "The French Penetration of Morocco," *Geogr. Rev.*, Vol. 8, 1919, pp. 56–58, and for the latest phase, "La pacification du Maroc français," *Renseign. Colon. (Suppl. à l'Afrique Française)*, Sept., 1922, pp. 241–247.

regions, largely from historical causes. The northeastern corner, for instance, around Tunis and Bône, owes its distinctive character to the fact that it has been the seat of the realm proper of Carthage. We have been taught at school that victorious Rome destroyed Carthage. According to history, the town was razed to the ground, its site was plowed, and salt was sown in the furrows. We do not realize that such phrases as a rule are metaphors. A great people is not so easily exterminated.

Tunisia is dotted with what the archeologists term Neo-Punic steles, that is tombstones with Punic epitaphs dating from every period of the Roman empire, centuries after the supposed destruction of Carthage. One of the greatest Roman emperors, Septimius Severus, who ruled the empire with great efficiency at the end of the third century of our era, was a North African. He was born in Leptis Magna, one of Carthage's colonies (Tripoli). We are told by historians that he always used the Punic language in his family. St. Augustine, who died a bishop at Bône early in the fifth century, tells us how it was one of his duties to provide Punic-speaking priests or interpreters for that part of his flock which understood nothing but Punic. Procopius shows that use of the Punic language in Tunisia survived to the time of the Byzantine empire. In fact it may be said never to have died. It is a Semitic language akin to Arabic. Tunisia has been practically Arabic-speaking for 2500 years. Again the ruins of Carthage are still to be seen, not ill preserved, in a suburb of Tunis; and Tunis is practically Carthage with a modern name.

This is all significant. Tunis is the only place of French North Africa where Egyptian nationalist influence is at work. True it is that part of Africa Minor nearest to Egypt: but probably it is not quite wrong to imagine that somehow, subconsciously, old Carthage would back the young Tunisian nationalism if such a thing should come into existence, as the old Egyptian Pharaohs are not to be forgotten as a background to Egyptian nationalism. Thousands of years of glorious history are not a small matter when it comes to explaining the arousing of national feeling.

The Great Towns

According to the greatest of Arabic historians, Ibn Khaldun, it was not until so late a date as the end of the fourteenth century that the Arabic language proper was really at home in the Maghrab except in the towns. The Arabic conquest of Maghrab in the first century of Mohammedanism was achieved by a regular imperial organization, that is by the army and administration of the caliph. They wanted barracks for their soldiers and offices for their clerks; and they built some towns or used those which had been already the abode of the foregoing Byzantine and Roman empires. Berber dialects were of no use in the towns for official purposes; a regular written language, not a dialect, is needed to meet daily emergencies of government and general business. Latin, that had been used for such

purposes, could only be superseded by Arabic, and it was. From the seventh to the fourteenth century, then, we must picture the towns of North Africa as islands of Arabic language and foreign civilization in a sea of wild Berber-speaking tribes.

Town life, which never was extinguished in Tunis, developed far later in Morocco. Fez was built only in the eighth, Marrakesh in the eleventh century. At that time the real heart of western Mohammedanism beat across the Strait of Gibraltar in Andalusia. After the fall of the Moorish kingdoms in Spain the refugees of Cordova and Granada brought a very important reinforcement of Arabic culture into the North African cities.

Between city and country in the Orient there is a chasm of which we have no idea. A Mohammedan town is not a thing that has grown gradually from small beginnings, as ours usually have. It has been built all at once by special order of the sultan.[6] That a city thus born should outlive the dynasty which has given it birth may happen; it did in the case of Fez or Marrakesh. But this is far from being the rule. Many instances to the contrary could be mentioned, amongst them Rabat on the Atlantic coast of Morocco. Rabat was built by Sultan Al-Mansur, the victor of Alarcos, one of the heroes of the Spanish wars. And it died with him before having been completed. For 700 years it has been standing, an immense city, within high walls, georgeous and empty, half unfinished and half ruined; a curious sight for Europeans.

Peasants living around such artificial cities cannot feel about them as our people do. The town is not their pride, their capital, a thing produced by themselves and partaking of their fortune. It reminds them of the master or even of the foe. Country and town may exchange products; they scarcely mix their blood, they live apart. Up to the coming of the French the town gates had to be closed at night; a kind of very dangerous no-man's land running between them.

Such cities, isolated for many centuries, have no intercourse, no common feeling or policy with the other large cities. The two chief towns of the Maghrab, Fez and Tunis, are different worlds.

Zenata and Bedouins

Had the towns remained all through history the only centers of diffusion for the Arabic language, it would probably not have been diffused at all. The most efficient teachers of Arabic in the Maghrab have been the Arabic Bedouins.

Their coming was a second Arabic invasion, many centuries after the first and very different from it. The Bedouins were not regular soldiers and officials, they were wandering nomadic tribes, complete families with wives and children included. It was colonization following conquest. It is a long way from Arabia to Maghrab, with serious intervening obstacles,

[6] Jules Blache: Modes of Life in the Moroccan Countryside, *Geogr. Rev.*, Vol. 11, 1921, pp. 477–502; reference on pp. 487–488.

the Red Sea, Egypt, and the hardships and dangers of the Sahara. The Bedouins were centuries coming along that way, but they arrived at last. They appeared first in Africa Minor in the twelfth century; and they spread out all over the country in the thirteenth and fourteenth. They brought destruction along with them and are chiefly responsible for the impoverishment and downfall of Maghrab.

They spoke rough Arabic dialects very different from the language of the towns-people, by whom they were both hated and despised. But they made themselves very useful to the sultans, who wanted strong men as mercenary soldiers, and flourished in consequence.

Their chief supporters were the Berber-speaking nomadic tribes, the bulk of whom are called Zenata. Having to choose between the other Berbers, those who lead a sedentary life, on one side, and the nomadic foreigners, on the other, they put themselves on the side of the foreigners. The loathing of nomads for sedentaries goes far deeper than any feeling of kinship. Bedouin colonists seem to have been few in number; and very likely in the veins of an average Arabic-speaking nomad there runs more Zenata blood than Arabic. The fact is that in Africa Minor every real nomad, of the camel-breeding kind, speaks Arabic and boasts of being an Arab.

The Bedouins have been supreme in the flat country, everywhere where cavalry can spread itself. But they never could do anything in the mountains against the infantry of the sedentary peasant.

They came into Africa Minor at the great gate of Biskra, a deep and broad cut through the Saharan Atlas, whence they spread themselves all along the high plateau. Further on in a westerly direction they came to the gap of flat country between Rif and Atlas (couloir of Taza) at one end of which lies the Algerian town of Tlemsen, at the other the Moroccan city of Fez. From there they covered the whole expanse of flat country bordering the ocean.

This is the key to the language map. It explains why both Arabic- and Berber-speaking natives are broken up in disconnected patches to a considerable extent in accord with the geographical distribution of mountainous and open country.

Architecture

The duality found in languages in French North Africa is found too in the architecture of dwellings. Every house is adjusted more or less to the individual that dwells in it; snails and oysters do not use shells of the same pattern. The people in Africa Minor use two kinds of roofs. One is the kind that Europeans are accustomed to, with a gable, a single or double slope, and a covering of tiles. The other is a terrace, generally whitewashed, such as everybody remembers having seen in pictures of Oriental towns.

The roofs in Kabyle villages are of the first kind, and so are they in a few little towns like Constantine, which is very near to Kabylia. At first glance one is reminded of Spanish, Italian, or southern French landscapes.

Most towns, especially the big cities, Tunis, Fez, Marrakesh, have the oriental terraced roofs, and in outward appearance they are much like any city in Egypt, Palestine, and Mesopotamia.

It may be objected that people build their roofs according to opportunity and climate; they build sloping roofs in the mountains where heavy snows and rains are apt to fall, terraced roofs in the low open country with a warm, sunny, and dry climate.

FIG 7

FIG. 8

FIGS. 7 and 8—Shawiya inhabitants of the Aures and their dwellings (village of M'naa). Note the flat roofs. They fill no social need as in the Arab regions (compare Fig. 5) but are a positive inconvenience during the time of winter snowfall. They bespeak the penetration of Oriental influences.

However, Constantine and Tlemsen lie about at the same altitude above sea level and do not differ greatly in average snowfall. Now Constantine is a typical tile-roofed town and Tlemsen a not less typical flat-roofed town. But, while Constantine has been more in touch historically with Kabylia, Tlemsen has been associated with Zenata and Arabs.

Two little towns lying not far from each other or from the sea, Ténès between Algiers and Oran, and Mazouna inland, have different roofs. The town with tile roofs is Ténès, and there is no mystery about the explanation. It was founded after the downfall of the Moorish kingdoms in Spain by refugees from Andalusia, and they brought with them the kind of European roof to which they were accustomed.

The most interesting case is probably the instance of the Shawiya dwellings. The villages in the Aures Mountains are rather puzzling at first glance.

The manner in which the little houses cluster on the hill tops reminds one of the Kabyle villages; but every house has a terraced roof. The puzzle only increases if you speak with the Shawiya. They complain about their terraces, a great nuisance in winter, because the snow has to be swept out carefully after every storm, or the adobe roof would fall in. Why then do they not use another kind of roof, one better adapted to the climate? They would not know how to do it; they are just building along in the old lines, according to time-honored tribal usage. In the Shawiya country, where nomadism and sedentary life have vied with each other, the architecture bears testimony of both influences, the European and the Oriental.

This difference in the house roofs is not such a small matter as it may look at first glance. It is, in fact, of paramount importance from a social point of view. In Oriental towns where the family lives up to the Mohammedan ideal, every house turns to the street a blind wall without windows; all the apertures of the rooms look inside the house upon the central yard, the *patio* of the Spaniards. This prison-like aspect of the house is in accordance with the secluded life of the harem. Mohammedan women live indoors, and the street is for them practically forbidden ground. But it is impossible to restrict them to the *patio*, to spend all their life confined to a courtyard, almost as deep, narrow, dark, and damp as a well. The flat roofs are for the women: men are forbidden to tread them as strictly as women are forbidden to tread the streets.

From the top of a minaret you look at the world of terraces spreading itself below you. All the terraces appear pretty much at the same level, and many bridges have been carried from block to block. This is why Oriental towns have far more *impasses* than streets, and why subway-like *passages couverts* are so numerous. The terraces have been built in such a way that it is easy to walk along on them from one end of the town to another. This is the realm of the women. Here they get their share not only of sunshine, but, what is no less important, of social intercourse. From terrace to terrace they exchange greetings, visits, abuse, and gossip; and here they enjoy life generally. Without the terraced roofs real Mohammedan family life would be impossible. In towns with tile roofs you may be sure that the seclusion of women has been more or less disregarded.

A brief study of architecture leads us to the same conclusion as does the language map.[7] In French North Africa two different worlds, west and east, are interwoven. This is what makes the distinctive character of Maghrab; it has two souls, and it has never known exactly to which civilization it belonged, eastern or western.

Mzabite and Jew

This essential duality prevented Maghrab from forming a political body. But as a consequence, Maghrab has been further subdivided—into so

[7] Cf. map (Pl. VII) accompanying Augustin Bernard and Edmond Doutté: L'habitation rurale des indigènes de l'Algérie, *Ann. de Géogr.*, Vol. 26, 1917, pp. 219–228.

many parts that it would be foolish to try to count them. One or two instances may be given here.

The most peculiar tribe in Algeria is perhaps the Mzabites. Mzab is far away in the desert (see map, Fig. 1). Not only is the surrounding country most uninviting, but in the very oasis, under the shadow of palm trees, the only way of getting water is to draw it from wells 180 feet deep. In such a place the annual expenditures are far greater than the incomes; every onion costs ten times what it may be worth. Mzab is really the fancy garden of rich business men.

In every Algerian town you will see Mzabite shops, where everything is sold, from vegetables to rugs or dry goods. Those shops, not the Mzab proper, are the real home of the Mzabite. Mzab is the place where every Mzabite business man may go on a vacation once in two or three years for a few weeks; it is the stronghold where he may bury money or hide precious religious books; a place where he gets his children educated. Tomorrow they may shift this stronghold and garden to another spot, as they have done in the past more than once. They are not attached to any particular geographical location. The very name we know them by, Mzabite, is only a popular appellation and not a topographical name. They call themselves Ibadits, which is the name of a well-known Mohammedan sect, pretty much akin to our Christian Puritans. By strict intermarriage for ten centuries they have developed into a race; they resemble one another physically and can be recognized at once when seen in the street. But in their own eyes they do not consider themselves as a race any more than they claim to belong to a geographical country. They just are Ibadits. Other Ibadits live in far-away corners of the Mohammedan community; some at Muscat in southeastern Arabia; some at Zanzibar. With these the Algerian Mzabites feel themselves connected by a brotherly link. But they loathe to the utmost their neighbors, the other Algerian Mohammedans.

The Mzabites are one of the numerous "nations" making up Africa Minor. This kind of nation, so strange in our European eyes, is a common feature in Eastern political and social life. The Parsis in India, the Armenians in the Turkish empire, and above all the Jews everywhere are exactly of the same national pattern as the Algerian Mzabites. They are a nation without a country, geographically speaking, scattered about over a wide expanse, and yet a nation with the most exclusive and passionate national spirit. Religious feeling is theoretically the only link, even if it has led practically to racial unity. And, curious to say, in every case, acute understanding of money matters and a shrewd feeling for business have become the leading characteristics of the community.

The Jews also are to be found in Maghrab; they, too, are one and not the least important nation amongst the medley of native races in French North Africa. Up to now they are the only race that has gone entirely over to the French. They have become French citizens and have discarded Arabic as the language of instruction in the schools.

THE HISTORICAL GEOGRAPHY OF EARLY JAPAN*

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It is matter for congratulation, in view of the steadily growing interest in the question, that the accumulation of evidence from various sources begins at length to throw some definite light on the origin of the Japanese people. Much confusion has existed on this subject hitherto, owing mainly to the fact that the work of investigators along different lines had been insufficiently collated and correlated, while at the same time the methods of interpretation were not altogether free from fault. A solution of the problem is not to be attained by a study of conditions and events in the Japanese islands alone. The same causes which have brought about the various contacts, friendly or hostile, between Japan on the one hand and eastern Siberia, Korea, Shantung, and the southeastern Chinese littoral on the other, during the past three decades, have been at work without intermission ever since the first settlement of man in this portion of the globe. The developments, political, social, economic, whose course we have followed with such close attention during the past few years are but the latest phase of a process whose beginnings are lost in the darkness of prehistoric time. It is thither that we must trace them if we would arrive at anything like a right comprehension of the foundation upon which rests the national life of Japan.

First Contemporary Accounts of the Japanese People

Derived without exception from Chinese sources[1] are our first contemporary accounts of the Japanese people, two thousand years ago. The region at that time occupied by their various tribes embraced not what we think of as the Japanese islands, but only their westernmost portions, together apparently with the southern end of the Korean peninsula and the large island known to us as Quelpart, lying out in the Yellow Sea. As will be seen, it was not until the seventh century of our era that the Japanese became in reality wholly an island people. Hence insularity was far from being the geographical factor of most weight in their early development. Of vastly greater significance was the fact that during their formative period they were in such close touch with the various civilized communities of the continent.

* Read at the Joint Meeting of the Association of American Geographers and the American Geographical Society, April, 1922.

[1] See for an account of these, James Murdoch: A History of Japan, Yokohama, 1910, Vol. 1, pp. 31 *et seq.* For accounts of what the Chinese writers have to say regarding the early Japanese, see E. H. Parker: Ma Twan-Lin's Account of Japan up to A. D. 1200, *Trans. Asiatic Soc. of Japan*, Vol. 22, 1894, pp. 35–68; also, Albert Tschepe: Japans Beziehungen zu China seit den ältesten Zeiten bis zum Jahre 1600, Yenchow-fu, 1907.

FIG. 1—Map to illustrate geographical relationships in early Japanese history. Numbers indicate the main cultural foci: 1, northern Korea (the kingdom of Chao-hsien is here shown in its later stages, earlier it extended across the Yalu basin); 2, southern Korea; 3, Kyushu; 4, Izumo; 5, Yamato. Letters have reference to successive Ainu frontiers. The conquest and absorption of the Ainu had pushed the Yamato frontier as far eastward as the Lake Biwa region (A) before the close of the prehistoric period. The line B—B represents the next great advance, just at the dawn of the historical period, and C—C the frontier as it existed about the time of the loss of the continental possessions of the Yamato. The line D—D was reached by the Japanese about the beginning of the eighth century, and the occupation of the main island may be regarded as completed, in its broad outlines, by the close of the tenth century. Scale of map approximately 1: 22,500,000.

The effect of winds and currents was also much slighter than is often claimed. The sail was still quite unknown in Far Eastern waters in those prehistoric ages when the peopling of the Japanese islands was going on, so that there was no way in which the monsoons could exert any particular influence upon the course of migration.[2] And the southern element, so clearly apparent in both the people and their culture, came not from those equatorial regions whence flows the Japan Current but from a direction at right angles to it, the seaboard of China, in days before Chinese civilization had yet reached the coast. Those who speak of a Polynesian or a Malayan strain in the Japanese ignore entirely the historical aspect of the problem; the great Polynesian diffusion did not take place until long after the emergence of the Japanese people, while the Malays do not appear on the scene until later still. The real effect of the southwest monsoon and the warm tropical current has been a climatic one. To them it has been due that the type of culture developed during prehistoric times in the southeastern coast lands of the continent could find in the southern and western portions of the Japanese archipelago those conditions of warmth and humidity requisite to its survival and further development.

Of Paleolithic man in Japan there has so far appeared absolutely no trace, and it is altogether likely that the islands, together with the east of Asia generally, remained unpeopled until geologically very recent times.

The earliest inhabitants of Japan of whom we have any knowledge were the ancestors of the existing Ainu of Yezo (Hokkaido), who at one time occupied the entire archipelago, remaining in undisturbed possession during a period which may well have extended over several thousand years.

At length, probably far back in the first millennium before Christ, if not indeed earlier still, there began a fresh invasion of the Japanese islands, this time by peoples belonging to various branches of the great Mongoloid stock, from eastern Siberia to the south Chinese littoral, with probably in the latter case a slight Negrito admixture. The result of the minglings in varying proportions between these newcomers and their predecessors forms to this day the great bulk of the Japanese population.[3]

Finally, commencing not long before our era and recurring at intervals for several centuries, there was a series of immigrations of northern Mon-

[2] On the late introduction of the sail in Japanese waters, see B. H. Chamberlain(transl.): Ko-ji-ki, or Records of Ancient Matters, *Trans. Asiatic Soc. of Japan*, Vol. 10, 1882, Supplement; reference in Introduction, p. xxv; H. A. C. Bonar: On Maritime Enterprise in Japan, *ibid.*, Vol. 15, 1887, pp. 103–125; reference on pp. 107 and 111; W. G. Aston: An Ancient Japanese Classic (The *Tosa Nikki*, or Tosa Diary), *ibid.*, Vol. 3, Part II, Jan.–June, 1875, pp. 121–130; reference on p. 124.

[3] Regarding this question of the composition of the Japanese people, see the following: K. Hasebe: Study upon the Human Bones found at Kô in the Second Excavation, *Rept. upon Archaeol. Research in the Dept. of Literature, Kyoto Imperial University*, Vol. 4, 1919–1920; *idem:* The Excavation of the Shell-Mound at Tsukumo, a Neolithic Cemetery in the Province of Bitchû, *ibid.*, Vol. 5, 1919–1920; H. Matsumoto: Notes on the Stone Age People of Japan, *Amer. Anthropologist*, Vol. 23 (N. S.), 1921, pp. 50–76; Katsuro Hara: An Introduction to the History of Japan, N. Y., 1920, pp. 48 *et seq.*; H. ten Kate: Notes détachées sur les Japonais, *Bull. et Mémoires Soc. d'Anthropol. de Paris*, Ser. 5, Vol. 9, 1908, pp. 178–195; E. Baelz: Prehistoric Japan, *Ann. Rept. Smithsonian Instn. for 1907*, pp. 523–547; Frank Brinkley: Primeval Japanese, *ibid.*, 1903, pp. 793–804.

goloids—Chinese and Koreans in the historical sense—whose influence, physical but more particularly cultural, has been largely confined to the upper strata of Japanese society.

The Ancestral Ainu

The first of these races, that of the ancestral Ainu, seems to have reached the Japanese islands in at least three successive waves, perhaps separated by long intervals of time.[4] Recent studies have shown that it was divided into several subtypes, at least two of which appear to survive in the existing Ainu. That the language of this ancient race was essentially that still spoken by its surviving representatives in the island of Yezo is indicated by the fact that place names occur all over the Japanese islands, from end to end, and possibly even in the Loochoo group, which can only be explained in terms of Ainu speech.[5]

Fig. 2—Ainu man and women at Piratori, island of Yezo; the man has ceremonial headdress and moustache lifter. The designs on the clothing are distinctive of this race.

Regarding the origin of this primitive people we are still wholly in the dark. Some have seen in them a kinship to the prehistoric European race known as that of Furfooz-Grenelle. Language tells us nothing; for, aside from loan words from neighboring tongues, the Ainu speech stands entirely isolated.[6] Physically there is no evidence of connection with the Mongoloid family, save for such interminglings as have taken place in relatively recent times. Many investigators have regarded the Amur region of Siberia as that from which this ancient race entered Japan. The fact should not be overlooked, however, that individuals of Ainu type are by no means unknown in Korea, while a possible relationship has also been suggested between the Ainu and the Pre-Dravidian tribes of India, or even with the natives of Australia.

Perhaps we may say, in the light of all the available evidence, that the few thousand Ainu still remaining, as well as the related stocks inhabiting Japan in days prior to the advent of Mongoloid man, represent an extremely

[4] See regarding these ancestral Ainu, in addition to the papers by Hasebe and Matsumoto, already cited, N. G. Munro: Prehistoric Japan, Yokohama, 1911, pp. 37–292 and *passim;* also Hara, *op. cit.*, pp. 31 *et seq.*

[5] Regarding Ainu place names in Japan, see B. H. Chamberlain: The Language, Mythology, and Geographical Nomenclature of Japan Viewed in the Light of Ainu Studies, Tokyo, 1887; also, Romyn Hitchcock: The Ainos of Yezo, Japan, *Rept. U. S. Natl. Museum for the Year Ending June 30, 1890*, pp. 429–502; reference on p. 434.

[6] Berthold Laufer: The Vigesimal and Decimal Systems in the Ainu Numerals: With Some Remarks on Ainu Phonology, *Journ. Amer. Oriental Soc.*, Vol. 37, 1917, pp. 192–208; reference on p. 205.

ancient generalized human type from which more than one of the wavy haired and heavily bearded races of Europe and southern Asia have been specialized.[7]

Of the culture of the ancestral Ainu, thanks to the somewhat extensive excavations of the past few years, we know considerably more than we do of their origin. They were already in the Neolithic stage as far back as they have been traced. They manufactured polished stone implements and a highly interesting and very ornate type of pottery, made, of course, without the aid of the potter's wheel. They seem to have derived part of their

FIG. 3—Old Ainu man operating canoe ferry in interior of island of Yezo. The Ainu, in common with other North Pacific peoples both of Asia and of America, were expert canoemen.

subsistence from the cultivation of millet, although doubtless dependent mainly upon hunting, fishing, and various wild vegetable products. Of domestic animals, with the exception of the dog, they were entirely ignorant. In summer they lived in rough huts and in winter in earth-covered lodges constructed either partly or wholly underground. Dwelling mainly on the coast and knowing how to make large dugout canoes, they were fearless seafarers, hunting the whale as well as smaller marine animals and, in later times, meeting the fleets of war boats of the invading Japanese in fiercely contested naval combats from which the newcomers by no means always emerged victorious.

Of their social, political, and military organization we can infer but little. It seems clear, however, that in these respects they were scarcely if at all behind the earlier comers of Mongolian extraction who settled among them; for they were able to keep the latter pretty closely confined to the extreme western portions of the Japanese archipelago for many centuries. It was simply and solely the stubborn geographical fact that the Mongoloids always had free access to the civilizing influences emanating from the continent.

[7] On the classification of the Ainu, see George Montandon: Notice préliminaire sur les Aïnou, *Archives Suisses d'Anthropologie Générale*, Vol. 4, No. 3, 1921, pp. 233–246; reference on p. 242; also, A. F. Chamberlain: The Japanese Race, *Journ. of Race Devel.*, Vol. 3, 1912–1913, pp. 176–187; reference on p. 182.

while the Ainu had not, that inevitably swayed the balance in favor of the former, and in the long run sealed the fate of the aborigines as a distinct ethnic entity.

Early Mongoloid Invasions

We know from various sources that southeastern Asia prior to the rise of the Chinese civilization was occupied by a race of Mongoloid stock, akin to the existing peoples of Indo-China and Indonesia, whose original culture, of a generalized Neolithic type, had taken on a distinctly southern and maritime aspect. That it was in contact, however, with more northern regions is

Fig. 4—Type of Japanese fishing with aid of large dip net, introduced from southern or central China.

shown by the occurrence both in Shantung and in Japan of the grooved stone ax, a type of implement found likewise in the North Pacific area.[8] The discovery again both in China and in Japan of the peculiarly shaped objects known in the latter country as *seki-bo*, or "stone clubs," also indicates a former widespread community of culture, extending in this instance even to the Ainu.

Socially, this southeastern Asiatic culture seems to have been characterized by descent in the female line, by seasonal mating festivals, and, at least in the ruling families, by brother-and-sister marriage.[9] The economic life, based primarily upon fishing, with doubtless some hunting, had been enriched before the close of the Neolithic period by the acquisition of various food plants, cultivated with the aid of the hoe alone. Among methods of bodily ornamentation were blackening of the teeth and tattooing. But little clothing was worn, save in cold weather; and the habit of promiscuous bathing, with a total indifference to bodily exposure, was general. No domestic animals other than the dog and the fowl appear to have been

[8] On this question of the grooved ax, see Berthold Laufer: Jade: A Study in Chinese Archaeology and Religion, *Field Museum of Nat. Hist. Publ. 154* (*Anthropol. Ser., Vol. 10*), Chicago, 1912, pp. 50 *et seq.*

[9] For its former existence among the Japanese, see B. H. Chamberlain: *Ko-ji-ki*, Intro., pp. xxxviii and xlv; W. G. Aston: Shinto (The Way of the Gods), London, 1905, p. 91.

known. In the absence of metals, great use was made of bamboo, although stone and bone were also utilized in various ways. There is some reason to believe that the spear rather than the bow was the weapon most commonly in use. As befitted a culture essentially amphibious in type, large canoes were made, each usually ornamented at the bow with the carved head of a crocodile or an alligator.[10] The religion was one of nature worship, with a strongly anthropomorphic trend and a highly interesting body of folklore. Possibly as a result of the matrilineal organization of society, the principle of reproduction and growth received special veneration, and goddesses were particularly in evidence. Ancestor worship, where found at all in this area, appears only late and then as a consequence of the introduction, among the higher classes, of a patriarchal type of family in imitation of the Chinese. Practically all these culture elements are traceable in Japan, some of them surviving to this day, while others have disappeared only in comparatively recent times.

From the end of the promontory of Shantung to the corresponding projection on the opposite coast of Korea it is only a trifle over a hundred miles —a stretch of sea easily negotiable by such inveterate sea rovers as were the Neolithic coast peoples of eastern and southeastern Asia. The strait between Korea and Japan is almost exactly the same distance across; and here there are islands where early voyagers could conveniently break their journey. It seems likely for a number of reasons that the colonization of Japan by the Mongoloid peoples of the neighboring continent took place largely by way of Korea. Probably, however, even within the Neolithic period a good deal of migration went on also directly across the Yellow Sea. The distance here is something under five hundred miles, with the lofty island peak of Quelpart, already mentioned, forming a natural stepping-stone.

This migration of peoples into Japan, to be properly understood, must be viewed as a phase of that great ethnic movement which brought about the colonization by the so-called yellow-brown races of so much of the enormous area extending from Japan on the east to Madagascar on the west. When this process began, we are as yet unable to say; but it seems not unlikely that one of the contributing factors was the pressure generated by the slow expansion coastward of the Chinese in the second and first milleniums before Christ. The disturbances set up, for example, by the Chou conquest of the Yellow River basin, about the eleventh century before our era, were felt far and wide and must have led to much shifting of peoples both by land and by sea.[11] Again, when the "barbarian" kingdom of Yüeh, corresponding

[10] A crocodile (*Crocodilus porosus*, or "Estuarine crocodile") seems to have been found anciently all along the southeastern Chinese coast at least as far north as the Yangtze delta, although now practically exterminated; cf. Arthur Stanley: The Collection of Chinese Reptiles in the Shanghai Museum, *Journ. North-China Branch of the Royal Asiatic Soc.*, Vol. 45, 1914, pp. 21–31, reference on p. 23.

A true alligator (*Alligator sinensis*), smaller than the American forms and rarely exceeding six or seven feet in length, still occurs in the Yangtze, although it is by no means common; cf. A. A. Fauvel: Alligators in China, *ibid.*, Vol. 13 (N. S.), 1878, pp. 1–36 f.

[11] Compare C. W. Bishop: The Geographical Factor in the Development of Chinese Civilization, *Geogr. Rev.*, Vol. 12, 1922, pp. 19–41.

roughly to the modern Chinese province of Chekiang, overthrew the rival state of Wu, in the Yangtze embouchure region, in 473 B. C., the ruling class of the latter are said to have made their escape to certain islands to the eastward, which can hardly have been other than the western portion of the Japanese group.[12]

The earliest distinct reference to Japan in the Chinese writings, however, is one in the work known as the *Shan Hai Ching*, to the effect that the northern and southern Wo are tributary to Yen, a Chinese feudal kingdom at the head of the Gulf of Chihli.[13] Inasmuch as Yen ceased to exist as an independent state in the year 226 B. C., this notice carries us back at least as far as the middle of the third century before our era, and possibly even farther still, since we know that Yen had been sending out exploring expeditions by sea as early as the reign of King Wei (378–343 B. C.).[14] We need not infer, however, that an actual conquest by Yen of any part of the Japanese islands ever took place. As is well known, it was long an official convention in China that all outsiders resorting to her for purposes of trade came to her as "tribute bearers." It may therefore be fairly concluded from the passage in the *Shan Hai Ching* that the two Wo peoples were in the habit of sending trading parties to Yen which had the cognizance of its government in days when foreign commerce was kept as far as possible a close state monopoly.

Precisely where the two Wo are to be sought, it is impossible to say. Perhaps the northern branch inhabited the lower extremity of the Korean peninsula;[15] or, on the other hand, they may both have dwelt in western Japan. That the southern, or "Great," Wo were located in Kyushu seems quite clear. For another name applied to their country by Chinese writers is that of Ye-ma-t'ai. This region, we are told, lay to the south of Korea—somewhere, that is to say, in the island of Kyushu—and contained a hundred petty kingdoms, all subject to the Ta Wo Wang, or great king of the Wo. It is further described as a maritime region with a late Stone Age culture, lying nearly due east of what is now the Chinese province of Chekiang and enjoying so mild a climate that vegetables were grown both winter and summer.[16]

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[12] Albert Tschepe: Histoire du royaume de Ou (1122-473 av. J.-C.), *Variétés Sinologiques*, No. 10, Shanghai, 1896, p. 156, quoting from the *T'ung-chien K'ang-mu*. Early Chinese writers describe an enchanted isle in the Eastern Sea where the customs are like those of the people of Wu; see E. H. Parker: Early Japanese History. *The China Review*, Vol. 18, 1889–1890, pp. 212–248; reference on p. 214.

[13] W. G. Aston: Early Japanese History, *Trans. Asiatic Soc. of Japan*, Vol. 16, 1888–1889, pp. 39–75; reference on p. 40 and in note 5. While the date of composition of the *Shan Hai Ching* has not yet been settled beyond dispute, the weight of evidence points toward the third or second century before Christ, although it undoubtedly contains much earlier elements.

[14] For the maritime explorations of Yen, see Édouard Chavannes, Mémoires Historiques de Se-ma Ts'ien (5 vols., Paris, 1895–1905), Vol. 3, pp. 436 *et seq.*; on the conquest of Yen by Ch'in Shih Hwang-ti in B. C. 226, *ibid.*, Vol. 4, p. 150. Inasmuch as the state archives of Yen, like those of practically all the rest of the ancient Chinese feudal states, have been lost, we know nothing regarding the details of her maritime explorations.

[15] Cf. E. H. Parker: China: Her History, Diplomacy, and Commerce, from the Earliest Times to the Present Day, 2nd edit., London, 1917, p. 21.

[16] H. Maspéro: *Bull. École Française d'Extrême Orient*, Vol. 9, 1909, pp. 593 *et seq.*; N. Peri, *ibid.*, Vol. 10, 1910, p. 715, note 1; C. E. Maitre: La littérature historique du Japon des origines aux Ashikaga, *ibid.*, Vol. 10, 1910, pp. 564–596; reference on p. 580, note 1.

FIG. 5

FIG. 7

FIG. 6

FIG. 8

FIG. 5—Ainu village. Note piles of firewood provided against the bitterly cold winter. The Ainu formerly used earth-covered dugouts as cold-weather residences, while their storehouses elevated on piles point to contact with southern insular peoples.

FIG. 6—Type of primitive Japanese hut surviving among modern peasantry. (Photograph by courtesy of the Freer Gallery of Art.)

FIG. 7—Famous shrine of the Sun Goddess at Ise, in which is preserved the primitive Japanese type of hut, allied to southern insular forms, very distinct from the Chinese style of architecture imported in historic times. (Photograph by courtesy of the Freer Gallery of Art.)

Now the winters of the Japanese Pacific seaboard are mild, it is true, thanks to the Japan Current. But nowhere are they mild enough to admit of the winter ripening of crops, save in certain favored localities of Shikoku and Kyushu; and of Shikoku in this connection there is no question. Yet several modern writers, influenced by the similarity in sound, have insisted upon identifying Ye-ma-t'ai with the Japanese province of Yamato, far away to the eastward, in the heart of the mountainous peninsula forming the boundary of the Inland Sea in that direction. It is hard to believe, however, that when the careful and evidently well informed Chinese historians speak of a maritime region with an extremely mild winter climate, lying far to the south, they really mean an inland province with a decidedly cold winter, situated in the distant east.

Nevertheless there may exist a connection between Ye-ma-t'ai and Yamato after all. Both the Chinese historians and their own legends represent the primitive Japanese as located first of all in Kyushu, where in fact the word "Yamato" does actually occur, as a place name in both Higo and Chikugo provinces.[17] We know further that this name has been applied by the Japanese people to themselves in a very definite way; *Yamato damashii*, for example, means the spirit of the Japanese people, not that of the province of Yamato. Hence it seems possible at least that "Yamato" was the name applied to themselves, while still in Kyushu, by the people whom the Chinese usually referred to as the Wo and that when, as we shall see, they transferred their seat of government to central Japan they carried their name with them.

Culture Areas in the Korean Peninsula

The Korean peninsula during these times, just prior to and about the beginning of the Christian era, was divided into two quite distinct culture areas. In the north and extending over into what is now southern Manchuria were various tribes with cultures basically akin to those of eastern Siberia generally, though beginning to be modified by influences both from the neighboring Chinese states and from Central Asia.[18] Farther to the south the peninsula was the home of the peoples called by the early Chinese writers the "Three Han." While the precise boundaries of these are unknown, generally speaking the Ma-Han occupied the west and southwest of the peninsula, with the Shên-Han to the east of them, on the Sea of Japan, and the Pien-Han in the extreme south. These three Han peoples were clearly recognized by their Chinese contemporaries as quite distinct from their northern neighbors, while on the other hand there evidently existed between them and the primitive Japanese an extremely close kinship if not indeed an

[17] Frank Brinkley and Baron Kikuchi: A History of the Japanese People from the Earliest Times to the End of the Meiji Era, New York and London, 1912, p. 84; W. G. Aston (transl.): *Nihongi*, Chronicles of Japan from the Earliest Times to A. D. 697, *Trans. and Proc. of the Japan Soc.*, Supplement 1, 2 vols., London, 1896, reference in Vol. 1, p. 226 and note 8.

[18] On the old Neolithic culture of eastern Asia, see R. and K. Torii: Études archéologiques et ethnologiques: Populations primitives de la Mongolie Orientale, *Journ. College of Sci., Tokyo Imp. Univ.*, Vol. 36, 1913–15, Art. 4; also review of same by H. Maspéro in *Bull. École Française d'Extrême Orient*, Vol. 14, 1914, pp. 79–80.

Fig. 5—Ainu village. Note piles of firewood provided against winter. (Photograph by courtesy of the Freer Gallery of Art.)
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Fig. 6—Type of primitive Japanese hut surviving among modern peasantry.
Fig. 7—Famous shrine of the Sun Goddess at Ise, in which is preserved the primitive Japanese type of hut, allied to southern insular forms, very distinct from the Chinese

actual identity. The same was also true, apparently, of the people of Quelpart Island, where traces of southern contacts are unmistakable to this day.[19] This entire region, in fact, formed in prehistoric times a distinct culture area whose closest connections are to be sought in the Chinese coast lands as they were before they came under the influence of Chinese civilization. It was only shortly before the beginning of the Christian era that bands of refugees, fleeing from the wars then devastating China, founded various states in southern Korea in which they introduced that Late Bronze Age culture which then characterized their own country. Shên-Han—later the kingdom of Hsin-lo, or Silla—in spite of its comparative isolation with regard to China, maintained especially close relations with that country, and the consequent superiority in culture which it enjoyed as compared with its immediate neighbors is evident throughout its history.

Introduction of Bronze and Iron into Japan

There can be little doubt that it was from these newly founded states of southern Korea that metal was first introduced into Japan. The history of bronze in that country is peculiar. It cannot, in fact, be said that a true Bronze Age ever existed there at all.[20] The records of the Later Han Dynasty describe the people of Wo, early in the Christian era, as still in the Neolithic stage of culture. This statement regarding their ignorance of metal at that time is strikingly confirmed by the discovery in various parts of western Japan, in association with stone implements, of Chinese coins of the first century of our era.[21] The histories of the Wei and Chin dynasties, on the other hand, referring to the third and fourth centuries, mention iron as known to the Wo. It would appear, therefore, that the very brief and wholly exotic bronze culture which archeological research has disclosed to us in Japan must have fallen somewhere about the second century or so of our era.

Bronze remains in Japan are few and far between, and such as there are occur only in the western portion of the country. They are quite unknown anywhere to the east of the Lake Biwa area, that isthmian region of central Japan where the Ainu held back their Mongoloid foes through so many centuries. Aside from ceremonial objects, the known remains consist mainly of swords, daggers, and arrowheads—all closely resembling well known Chinese Bronze Age types. The discovery of molds indicates that some casting was done in Japan; but the raw material and a great proportion of the finished articles seem to have been imported, either from Korea or even direct from China, as is also suggested by the name, *Karakane*, which

[19] H. B. Hulbert: The Island of Quelpart, *Bull. Amer. Geogr. Soc.*, Vol. 37, 1905, pp. 396–408, *passim*.

For the probable Japanese affinities of the people of Quelpart, cf. E. H. Parker in *Chinese Recorder and Missionary Journ.*, 1885, p. 303; also W. G. Aston, *Nihongi*, Vol. 2, p. 323, note 5.

A seventh-century king of T'am-na, as the island was then called, bore a name, Yuritoro, which has a decidedly Japanese sound.

[20] The British Museum's "Guide to the Antiquities of the Bronze Age," 1904, is hardly exact in stating that the Japanese were already in the late Bronze Age when they entered the islands; they had long been in Japan when the knowledge of bronze was brought to them. It was a case of a cultural, not a racial, migration.

[21] Dr. K. Hamada, of the Kyoto Imperial University, in personal letters of July 10, 1917, and Dec. 20, 1920.

may mean either Korean or Chinese metal. Introduced only after its use in China had already been largely superseded by that of iron, it was but a short time before bronze was overtaken and displaced by the later metal in Japan also. And so effectively was it eclipsed, save of course for ornamental and ritual objects, that neither the *Kojiki* nor the *Nihongi*,[22] the two earliest Japanese historical works that have come down to us, betray the slightest recollection of a former Bronze Age; the use of copper arrowheads upon one occasion being mentioned solely as something unusual.

But, if the influence of bronze upon the cultural development of Japan was thus slight, with iron the case was far otherwise. Historical notices are wanting; but good grounds exist for thinking that iron reached Japan merely as one element of an entirely different material culture complex, partly Chinese and partly Central Asiatic in origin,[23] which had taken form somewhere in Korea and which was far higher than anything that the Japanese islands had yet known. That this cultural invasion was the result of actual conquest of any part of the country in a military sense cannot be categorically stated; but the presumption seems on the whole in favor of something of the kind.

Other Evidences of Invasion from Korea

The evidence of language, for one thing, appears to point in this direction. Japanese belongs to an independent family, whose only other members are Korean and Loochooan, and such indications as there are point to central rather than to southern Asia as the region of its origin.[24] The most plausible conjecture—in the present state of our knowledge it can be nothing more—would seem to be that it reached Japan as the tongue of a relatively highly civilized body of invaders, not necessarily large, penetrating southward from the Korean peninsula and imposing their authority and their language upon the less civilized tribes, presumably of mixed Ainu and southern Mongoloid origin, whom they found in possession of the western portion of the islands. That such movements were constantly recurring within Korea itself, we know from the Chinese records. About 200 B. C., for example, when refugees from China conquered the state of Chao-hsien, in southern Manchuria, the king of the latter country escaped southward by sea with several thousand of his followers and secured a footing for a season in Ma-

[22] The *Kojiki* dates from 712 A. D., the *Nihongi* from 720. Chamberlain's translation of the former and that of the latter by Aston have already been cited. There is also another of the later work, by Dr. Karl Florenz: Nihongi, "Zeitalter der Götter," Tokyo, 1901.

[23] Among the traces of Central Asiatic influence upon the Early Iron Age civilization of Japan are the reliance upon horse archers as the principal fighting arm; the use of the *nari-kabura* or "sounding arrow;" the sacredness attached to certain horses, usually piebald or albino; sword worship; divination by means of a deer's shoulder blade; and the custom of burying living retainers about the tumuli of kings and nobles.

Bashford Dean, in his "Catalogue of the Loan Collection of Japanese Armor," *Metropolitan Museum of Art, N. Y., Handbook No. 14*, 1903, p. 28, points out that the earliest metal armor of Japan, about 800 A. D., shows a relationship in many ways to that of central and eastern Russia.

[24] Legge ("Chinese Classics," Vol. 5, p. 74) makes the interesting suggestion that a polysyllabic language may have been spoken among the pre-Chinese natives of Shantung. As is well known, Chinese is monosyllabic and tonal.

Han in the southwest of the peninsula, only eventually to be beaten out again.[25] That a similar raid, or series of raids, during the latter half of the second century of our era or thereabouts, should have been the means of introducing an Early Iron Age culture among the Wo, seems both possible and plausible.

The most conspicuous feature of this period in Japan, next to the use of iron itself, was the practice of dolmen burial. A careful study of the available data, both historical and archeological, points to Korea again, and probably to the northern rather than the southern portion of the peninsula, as the source whence was introduced into Japan this custom of burying the illustrious dead in megalithic chambers covered by vast mounds of earth. Dolmens, in general somewhat smaller and simpler in type than those of Japan, occur in Korea in large numbers, particularly in the north. Farther down in the peninsula their place tends to be taken by still simpler stone cists; but these contain horse trappings, stone models of metal swords and arrowpoints, and wheel-made pottery, all closely resembling and in most cases absolutely identical with corresponding remains in dolmen interments in Japan.

It is matter of historical record, reinforced by archeological evidence, that this type of burial came to an end in Japan about the seventh or eighth century. Regarding the date of its beginning, however, opinions have been widely at variance, although generally speaking it has been placed far too early.

While it is true that bronze and even stone objects have been found in connection with Japanese dolmen interments, that these are mere funerary survivals is shown by the fact that the vast majority of implements are of iron from first to last. The occurrence of horse trappings in these interments is of great significance. The Chinese records are most explicit to the effect that the people of Japan and of southern Korea at the beginning of the Christian era and for at least a century or two after had neither horses nor cattle. Hence, inasmuch as stirrups, bits, and other objects of iron are recorded as occurring throughout the Dolmen Period, it follows that the latter itself can only date back to the epoch of the introduction of iron and the horse, somewhere apparently about the end of the second century.

The Introduction of Agriculture Proper

To what extent the primitive Japanese in days prior to the advent of metal depended upon planting for their subsistence we do not know; but the Chinese accounts afford evidence of what is otherwise intrinsically probable, that they possessed a hoe culture, carried on in all likelihood largely if not exclusively by the womenfolk. Under such a system, for several reasons, no very great growth of population could ever take place. It was only the introduction of true agriculture, which in southeastern Asia means the grow-

[25] E. H. Parker: On Race Struggles in Corea, *Trans. Asiatic Soc. of Japan*, Vol. 18, 1890, pp. 157–228; reference on pp. 210 *et seq.*

ing of irrigated rice, that made possible the vast increase in numbers and consequent economic and military strength essential to the development of a powerful national entity. This great advance in civilization was another element of that distinctive culture complex characterizing the Japanese Early Iron Age. That it too was derived from Korea is indicated, among other signs, by the entire absence in Japan of the water buffalo, the plow animal *par excellence* in the irrigated rice culture of China, and the use in its stead of a bullock of identical breed with that of the neighboring peninsula.

FIG. 9

Fig. 10

FIG. 9—Japanese peasants digging edible bamboo shoots. The hat, raincoat, spade, hoe, and style of clothing are all traceable to the southern Chinese littoral.

FIG. 10—Japanese rice culture, introduced from south and central China, perhaps by way of Korea. Women in Japan still perform a large part of the field work, just as in primitive times. (Photograph by courtesy of the Freer Gallery of Art.)

Such a revolution in the economic life of a people as that implied by a change from a hoe to a plow culture has naturally its social aspects also. In hoe culture it is almost invariably the women who do the planting, while the men fish and hunt. No one exchanges the excitement and activity incident to the career of a hunter or a deep-sea fisherman for the monotonous drudgery that falls to the plowman's lot save under strong compulsion of some sort. In other words, the bringing about of such a change almost necessarily implies the relationship of master and serf. That such a system obtained in the Japan of the Early Iron Age, we have abundant evidence.[26] This fact affords additional presumption of conquest of some sort, whether from without or from within.

[26] On this see, e. g., Hara, *op. cit.*, pp. 80 *et seq.*

Historical Evidence from Chinese Records

For such historical evidence as exists regarding this phase of Japan's cultural development we are still forced to rely almost wholly on the Chinese records. Writing seems to have been applied in Korea to the keeping of annals only toward the close of the fourth century of our era, and in Japan somewhat later still, so that what is told regarding earlier periods must rest solely upon oral tradition and legend.[27]

The histories of the Later Han and the Wei dynasties of China inform us that for a period of seventy or eighty years, ending about the close of the

Fig. 11—Korean bullfight. These fights, originally of ritual significance, seem to have formed an element of the irrigated rice culture complex, in association with which they are found from Japan to Madagascar.

second century, the people of western Japan—from what cause, is not stated—were in great turmoil, the disturbances ending only with the rise of a powerful queen (almost certainly the "empress" Jingô Kôgô of Japanese legend) who by her command of magic extended her authority far and wide over the various tribes of the Wo.[28] She had, the accounts go on to say, no husband, but was assisted in governing by her brother—apparently an only partly understood instance of royal brother-and-sister marriage, a custom which we know formerly existed in Korea also.[29]

That a marked change of some kind, whether as the result of actual invasion or not, really did take place at this time is further shown by the fact that the Chinese records of the period sometimes refer to "Great Wo" by the alternative name of "the Queen Country," although declaring specifically

[27] Maurice Courant, Stèle chinoise du royaume de Ko Kou Rye, *Journ. Asiatique*, Ser. 9, Vol. 11, 1898, pp. 210–238, states (pp. 223 *et seq.*) that writing became habitually used in western Korea in the last quarter of the fourth century. W. G. Aston, *Trans. Asiatic Soc. of Japan*, Vol. 16, 1888, p. 46, thinks Chinese writing (there is of course no question of any other) was diffused in the various Korean kingdoms in the last half of the same century. C. E. Maitre, *op. cit.*, p. 584, says writing was definitely introduced into Japan from Korea at the beginning of the fifth century.

[28] See Murdoch, *op. cit.*, Vol. 1, pp. 36 *et seq.*

[29] Hulbert, *op. cit.*, p. 81.

that in earlier times it had been ruled over by kings. It seems to have been the case that these female rulers of the Wo derived their powers from a belief that they in some special sense—most likely through actual physical descent—represented the Sun Goddess, whose oracles and priestesses they were.

It was about this same period, apparently, that there arose on the main island, in what was later the province of Izumo, an independent kingdom which had especially close relations with the country of Hsin-lo, or Silla, facing it across the Sea of Japan.[30] It is perhaps in this Izumo region that is to be sought the land of Ko-nu, mentioned by contemporary Chinese writers as situated across the sea from Ye-ma-t'ai (in Kyushu, as we have seen), and more to the eastward. The people of Ko-nu, we are further told, although of the same race as the Wo, were generally on terms of hostility with the latter, and unlike them were ruled over by a king, who was in diplomatic correspondence with the Chinese representatives in Korea.

Thus it seems clear that beginning about the latter half of the second century western Japan was invaded from Korea by a decidedly high culture characterized by the use of iron, the manufacture of wheel-made pottery, the possession of domestic animals, the custom of fighting on horseback, the practice of true agriculture, and the burial of the illustrious dead in dolmens covered by huge mounds of earth. It is possible that the bow played a part in the extension of this culture; for the original Mongoloid settlers of western Japan, like their kinsmen of the Chinese littoral and so many of the modern peoples of Indo-China and Indonesia, appear to have been spearmen rather than archers.

Of the substitution of male rule for female rule among the Wo there is no historical record. But that it took place not long after the time of the great queen just mentioned, and that it was due to the growing influence of Chinese ideas, may be held as certain. The former divine queens seem to have survived merely as chief priestesses of the Sun cult, while the actual power was henceforth vested in the male heads of the ruling clan, the historical mikados, also of course descendants of the Sun Goddess and therefore god-kings in their own persons.

It was during this same period of her Early Iron Age that Japan received, through Korea but eventually from China, two fresh cultural acquisitions whose importance it would be difficult to exaggerate. These were the Buddhist faith and the art of writing. The story of the way in which these additional factors in the national life came to be introduced cannot be gone into here. But it will readily be seen how very great must have been their influence as unifying and civilizing agents among a congeries of tribes dwelling upon a relatively low culture plane and ruled over by a turbulent, disunited, and illiterate aristocracy which had as yet learned to pay but small respect to the authority of the central government.

[30] On the contact between Hsin-lo and the Izumo region of Japan, see Aston, *Nihongi*, Vol. I, p. 166 and note; W. E. Griffis: Corea, the Hermit Nation, New York, 1882; reference in Preface, p. v; Baelz, *op. cit.*, p. 525.

Extension of Japanese Occupation of the Main Island

The fact that bronze implements have been found only to the westward of the Lake Biwa region would suggest that the Mongoloid advance at the expense of the Ainu got no farther than that point until after the introduction of iron. It is possible, however, that even during the Neolithic period independent bands of the invaders may have cruised in canoes farther eastward, planting settlements along the coast but leaving the central mountain ranges in the hands of the aboriginal population. We know that it was by this method of coastwise advance in large fleets of war boats that the Japanese effected the conquest of much of the northern part of the main island in the full light of the historical period, during the seventh and eighth centuries; and it must have been by a similar process that they acquired a lodgment in the islands in the first place.[31] At all events there is some evidence, slight though it be and mainly of a legendary character, that the coastal plains as far east as Tokyo Bay were already occupied by settlements of peoples akin to but independent of the Yamato, when the latter established their supremacy there. The Yamato-dake story, for example, pure myth though it be in the main,[32] suggests this; for in it that hero appears as warring against peoples kindred to his own until he passes the mouth of Tokyo Bay (traveling by sea, be it noted); it is only beyond that point that he is represented as coming in contact with the Ainu.

It seems certain at any rate that the efforts of the Yamato to extend their authority over eastern Japan began very soon after their occupation of the Lake Biwa region. For the Japanese annals, just now beginning to have some slight historical value, mention a defeat inflicted at the end of the fourth century upon one of their war parties by the Ainu of the rugged peninsular region between Tokyo Bay and the Pacific Ocean. And eighty years or so later—in the year 478 A. D., to be exact—the Chinese records inform us that the emperor then reigning, Shun Ti, of the Early Sung Dynasty, received a letter[33] from the ruler of the Yamato, stating that his father had conquered toward the east fifty-five states of the Maojên, or "hairy men" (the Ainu, of course), and on the west sixty-six states of the I-jên, or "barbarians." Who these latter were, is uncertain; but they were perhaps most likely fragments of the pre-Yamato population of western Japan, of mixed Ainu and Mongoloid descent, which, dwelling in mountainous areas or outlying islands, had managed hitherto to escape conquest by the Yamato. Southern Kyushu in particular we know long remained independent and hostile. The almost entire absence of dolmens here indicates the slight control exercised by the Yamato over this region during their Early Iron Age, and this inference is most abundantly confirmed by their own records.

[31] Regarding these boat expeditions, see Aston, *Nihongi*, Vol. 2, pp. 252 and 263; also, Hara, *op. cit.*, p. 110.

[32] For the Yamato-dake myth see Aston, *Nihongi*, Vol. 1, pp. 200 *et seq.*; B. H. Chamberlain, *Ko-ji-ki*, pp. 201 and 205 *et seq.*

[33] Thus showing that the Japanese were now beginning to conduct their diplomatic correspondence in writing, if indeed they had not already been doing so for a century or two; but the art remained for long a secret confined to certain hereditary guilds of Chinese or Korean extraction, whose members thus acquired vast influence with the rulers and great nobles of the Yamato whom they served as scribes.

Loss of Continental Territory

But, though the influence of the Mikados was being strengthened during this period in Japan proper, as much cannot be said with regard to their relations with the continent. During much of the Early Iron Age western Japan and particularly northern Kyushu seem to have been far less closely allied in feeling to the Yamato region than they were to southern Korea. At times this consciousness of kinship actually took the form of alliances between the peoples on the two sides of the Strait of Tsushima for waging war —"rebellion" in the official Japanese phraseology—against the divine Yamato rulers of central Japan. It was only by great efforts that the latter were able to maintain even the loosest control over their kinsfolk of the lower end of the peninsula.[34] Geography, in the shape of the hundred miles of sea between Japan and Korea, was working as inexorably against them as did the English Channel against the retention of Normandy by the English kings—in many ways a closely parallel case.

Finally, in the latter half of the seventh century the age-long friendship between the kingdom of Hsin-lo, the ancient Shên-Han, and China, then under the sway of the powerful T'ang Dynasty, culminated in a joint attack upon the Yamato by sea and land, which resulted in their total expulsion from the peninsula. The people of Quelpart, of Japanese or closely kindred stock, kept up for several centuries a quasi-independent existence as the kingdom of T'am-na but eventually gravitated toward Korea, geographical propinquity proving stronger than the ties of race and culture.

At the time, no doubt, this loss of the continental portion of their territory must have seemed a catastrophe of the direst sort. In the long run, however, it proved of incalculable benefit.[35] For, while receiving just as formerly the culture stimuli emanating from the continent, the Yamato no longer had to dissipate their energies in efforts to retain hold of regions on the mainland which were steadily growing farther apart from them in feeling and culture. Thus, able to give their undivided attention to their home problems, they set to work in earnest to obliterate the last remaining frontiers within the Japanese islands themselves.

Further Consolidation of the Insular Domain

The independent communities still surviving in the west, of which those mentioned as existing in southern Kyushu were the chief, were absorbed in short order. The last rising of the old independent stock of southern Kyushu took place at the end of the seventh century, barely a generation after the expulsion of the Yamato from their last foothold on the continent. But the separatist tendencies of the region, fostered by its geographical configura-

[34] On the dominance of Japan in Korea during the early centuries of the Christian era, see Kanichi Asakawa: The Early Institutional Life of Japan, Tokyo, 1903, pp. 80 *et seq.*

[35] Hara, *op. cit.*, pp. 122 *et seq.*

FIG. 12

FIG. 13

FIG. 12—Typical Japanese torrent bed in winter. Owing to the almost total lack of navigable rivers, the original Japanese conquest was largely confined at first to seaboard plains accessible to their fleets of war boats.

FIG. 13—Lake Hakone, in central Japan, where the original Ainu long held back the Japanese invaders until outflanked by sea, as happened again and again, until the process of conquest had been completed.

FIG. 14

FIG. 15

FIG. 14—Winter scene in the Nikko range, part of the central backbone of Japan, in whose fastnesses Ainu types still sometimes occur in great purity.

FIG. 15—Looking north from the scarp of the ancient Japanese hill fort of Taga, toward the hills still held by the aboriginal Ainu in the eighth century.

tion, have been manifest throughout its history, the last instance being that of the famous "Satsuma rebellion" of 1877.

The subjugation of the still unconquered Ainu of the north and east presented a far more serious task. The mass of the people of western Japan, hardly touched by the new cultural influences from the continent, save in so far as these facilitated their exploitation by their rulers, had long since sunk to the status of abject predial serfdom and had lost such military virtues as they may once have possessed. The aristocracy, we know, were splendid warriors, gorgeously equipped and accustomed to fighting on horseback with longbow and sword. When called out *en masse* they no doubt proved a most effective if somewhat undisciplined militia. But aside from the personal guards of the rulers and great nobles, recruited largely from the Ainu and the pre-Yamato populations of southern Kyushu, there was no standing army and consequently no force ready at all times to take the field on short notice against the sudden incursions of the unconquered aborigines. These fierce fighters were by no means content merely to act on the defensive. Throughout their history as an independent people they evinced an entire willingness to meet their enemies quite halfway. Their usual method of waging war was to strike the settlements of the foe unawares and then be off again with their booty and captives, leaving behind them a trail marked in blood and fire, before troops could be brought up against them. The attitude of the bulk of the Japanese peasantry toward these savage raiders is vividly reflected in a very ancient song, attributed to the mythical hero Jimmu, which says that one Emishi (i. e. Ainu) is a match for a hundred men.

The Ainu Frontier

It was clearly for strategic reasons that the Yamato had moved their seat of government in the first place from Kyushu to the frontier region about Lake Biwa. For it was there that Ainu incursions were most to be dreaded and there, too, that they could be most easily repelled before they had penetrated far into the country. That such a radical change of base should have been made, in spite of the very great importance which we know the Yamato rulers attached to the maintenance of their hold on southern Korea, gives us a measure of the anxiety with which they regarded the "Ainu question." Only a motive of the utmost cogency could have induced them to remove so far from the position close to the Strait of Tsushima which they had hitherto occupied.

The settlement of the Ainu problem was at length effected; but it was only by dint of the hardest fighting, protracted through centuries. The possession of iron weapons and of a force of mounted archers accustomed to maneuver at a gallop over rough ground must have given the Yamato a great advantage over the Ainu in the open field. But as the latter were slowly pushed back northeastward they absorbed more and more of the civilization of their enemies with a consequent increase in their own powers of resistance, while the Yamato armies, on the other hand, advancing both by land and

by sea, met with ever greater difficulty in getting up their supplies from the cultivated districts far in their rear. Moreover, it was not enough merely to occupy the lowlands near the coast with blockhouses and military colonies. The central mountain ranges had also to be invaded and their inhabitants dispossessed or subdued, if there was to be any security for the always lengthening lines of communication. In view of the overwhelming difficulties attending the task, it is no wonder that it was so long of accomplishment; while

FIG. 16—Inscribed stone of the eighth century at the Taga fort, near the ancient Ainu Japanese-frontier, a few miles north of the modern city of Sendai.

the dogged stubbornness with which the centuries-long battle was waged on both sides says a vast deal for the fighting qualities of Ainu and Yamato alike.

For some reason progress was much more rapid on the west than on the east coast, so that about the close of the seventh century the Yamato had after a fashion occupied the territory along the Sea of Japan nearly up to the 39th parallel. On the Pacific side the Ainu were then holding out along a line roughly corresponding to latitude 37° N. The next few campaigns pushed the frontier back, on the west, as far as a spot a trifle south of latitude 40° N., where the Akita fort was built. From this point the boundary extended in a general southeasterly direction across the central mountain ranges to the Pacific, reaching the coast about in latitude 38° 40′ N., some fifty miles or so north of the Taga fort, whose overgrown earthworks still stand, not far from the present city of Sendai.[36]

[36] On the successive old Yamato-Ainu frontiers, see Hara, *op. cit.*, pp. 67 *et seq.*, 86 *et seq.*, 104, 119, 147 *et seq.*; N. G. Munro, Primitive Culture in Japan, *Trans. Asiatic Soc. of Japan*, Vol. 34, Part II, 1906, pp. 1–198; reference on p. 166; *idem*, Prehistoric Japan, p. 597.

At this point, in the latter half of the eighth century, the still unconquered Ainu made a desperate effort to regain their lost ground. They took the Taga fort, massacred its commander and garrison, and pushed far down the eastern coastal plain toward that Tokyo Bay region from which their ancestors had been driven something like three hundred years before.

But the Yamato government, albeit with difficulty, kept large forces in the field year after year, while the aborigines, barbarians as they were, aided in their own subjugation by indulging in suicidal wars among themselves. It was fortunate for them that the Yamato, before the loss of their continental possessions left them free to attend to their internal problems, had adopted the peaceful and humane creed of Buddhism with its aversion from bloodshed. For, in obedience to the behests of their faith, they carried on no mere war of extermination but made a genuine effort to civilize and assimilate the conquered natives and to place them on the same footing with the other subjects of the Mikado. At first prisoners of war were distributed in the western part of the islands in small bodies and were given rations until they should learn to become self-supporting; while later on the policy was adopted of organizing them into villages on the same basis as the rural population elsewhere. Thousands of them, first-class fighting men as they were, accepted enrollment in the Japanese armies for service against their still unsubdued kinsmen. Offices and gifts were bestowed on surrendered chieftains, while missionaries, in some cases themselves converted Ainu who had taken holy orders, made every effort to win the aborigines to the Buddhist faith.

Final Conquest of the Ainu

Finally by the close of the tenth century the subjugation of the Ainu of the main island could be regarded as accomplished. But it was long before they were completely assimilated. They rose again and again, even as late as 1332, while a few villages of them were still to be found about the shores of Aomori Bay so recently as the eighteenth century.

That portion of the race living in Yezo, Sakhalin, and the Kuriles retained its independence for some time longer. The last serious effort of the Yezo Ainu to expel the Japanese occurred in the latter part of the seventeenth century, when with their primitive weapons they made a brave but hopeless fight against their foes clad in iron armor and equipped with matchlock guns and keen steel swords.

As a distinct people the Ainu have almost wholly disappeared, with the exception of the few thousands still living in the island of Yezo. Nevertheless they form a very large element in the racial composition of the Japanese nation to this day.[37] As usual in cases where crossing has occurred between

[37] On the large Ainu part in the modern Japanese racial complex, see Kanichi Asakawa: The Origin of the Feudal Land Tenure in Japan, *Amer. Hist. Rev.*, Vol. 20, 1914–15, pp. 1–23; reference on p. 17; Matsumoto, *op. cit.*, pp. 73, 75 *et seq.*; David MacRitchie: The Ainos, *Internationales Archiv für Ethnographie*, Vol. 4, Supplement, 1892, *passim*; Romyn Hitchcock, *op. cit.*, p. 450.

N. G. Munro (Prehistoric Japan, p. 634) says the religion of the Yamato was much more deeply influenced by the Ainu than is generally supposed.

Mongoloid and other races, the external physical characteristics of the former have tended to be dominant, although apparently the same does not hold to quite the same extent regarding skeletal traits. Traces of Ainu mixture are visible throughout the country, from the Loochoos and Satsuma in the far south to Yezo on the north, while in isolated regions like the mountain fastnesses of Kozuke, Shinano, and Echigo provinces in the center of the main island, there still occur surprising numbers of pure Ainu types. Particularly strong was this strain among the former Samurai, or knightly class, in large part descended from the Ainu incorporated in the Japanese armies of the eighth and ninth centuries.[38] To this inheritance it was that the haughty two-sworded man of later times owed his less Mongoloid features, ruddier complexion, and heavier beard, to say nothing of his splendid fighting qualities.

It would be difficult to exaggerate the influence which the Ainu have exerted over the historical development of the Japanese Empire. For to the long centuries of warfare which their subjugation entailed were due the rise of that hereditary warrior class and that system of military government, without which Japan would almost certainly have vegetated into a second Korea—in other words, a feeble imitation of China, without either the will or the force to think and act for herself. It is pleasant to be able to state, from personal observation, that the Japanese authorities are doing all that they can to elevate and educate the remnant of the Ainu and assist them to a point where they can take their proper place as civilized men and women in the world of the twentieth century.

Conclusion

The physical and cultural traits which we regard as peculiarly Japanese may, then, be traced to three separate and distinct geographical areas.[39] Basically, both in race and in the fundamentals of their culture, the Japanese are most closely akin to the ancient inhabitants of the Asiatic coast lands during the Neolithic period. Superimposed upon this foundation and affecting mainly the ruling classes, was that higher type of civilization which began to reach Japan about the beginning of our era and which was accompanied by a certain infusion of fresh blood, largely from Korea but also to a not inconsiderable extent direct from China. Finally, to the long contact with the ancient aborigines were due the addition of a most valuable element in the racial complex and the acquisition of that fighting spirit, with its traditions of unflinching loyalty and self-sacrifice, that has been so largely responsible for the rise of Japan as a modern Power.

[38] Asakawa, Origin of Feudal Land Tenure, p. 17; Matsumoto, *op. cit.*, pp. 75 *et seq.*

[39] H. J. Fleure (Geographical Factors, Helps for Students Series, No. 44, London, 1921) makes the interesting suggestion that it may be the imperfect accord of widely separated inheritances in the same individual that has given the Japanese the sensitiveness to climatic differences which has hitherto stood in the way of their succeeding as colonists in Formosa or Sakhalin.

THE OCEANOGRAPHY OF THE PERUVIAN LITTORAL WITH REFERENCE TO THE ABUNDANCE AND DISTRIBUTION OF MARINE LIFE

By Robert Cushman Murphy
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The Humboldt Current, which flows northward along the Pacific coast of South America, is directly responsible for certain striking phenomena of oceanic distribution. It is responsible also for the existence in littoral waters of a vast abundance of marine organisms, upon which are dependent in turn unsurpassed fisheries resources, as well as the remarkable modern Peruvian guano industry concerning which authoritative information has recently become available.[1] Hydrographic and biological investigations in the Humboldt Current strike, therefore, at the roots of important problems of ecology, of the geographic distribution of life, and of the application of science to economic affairs. A discussion of these subjects in the light of information acquired during a recent expedition of the Brooklyn Museum[2] is the object of the present paper.

Characteristics of Oceanic Circulation Along the Coasts of America

For a comprehension of conditions in the Humboldt Current the circulation of both northern and southern hemispheres must be considered together; and, moreover, the system of the western coast of the Americas must be contrasted with the diametrically opposite expression of the same causes which obtains on the Atlantic side of the continents.

Owing to the progressive increase in the eastward linear velocity of the earth's surface from either pole toward the equator, masses (as of air or water) moving in the direction of the equator necessarily fail to maintain an easterly component equal to that of the parallels of latitude at which they are successively arriving. In other words, they "fall behind," or turn toward the right in the northern hemisphere and toward the left in the southern.[3]

[1] R. E. Coker: The Fisheries and the Guano Industry of Peru, *Bull. Bur. of Fisheries*, Vol. 28, 1908, Part I, pp. 333–365.

Idem: An Illustration of Practical Results from the Protection of Natural Resources, *Science*, No. 1370, Vol. 53, 1921, pp. 295–298.

J. A. de Lavalle: El guano y la agricultura nacional, Lima, [1914], p. 1–111.

R. C. Murphy: The Guano Industry of Modern Peru, *Brooklyn Museum Quart.*, Vol. 7, 1920, pp. 244–269.

[2] R. C. Murphy: The Seacoast and Islands of Peru, *Brooklyn Museum Quart.*, Vol. 7, No. 2, 1920, to Vol. 9, No. 4, 1922.

[3] For the mathematical explanation of this phenomenon see G. F. McEwen: Peculiarities of the California Climate Explained on the Basis of General Principles of Atmospheric and Oceanic Circulation, *Monthly Weather Rev.*, Vol. 42, 1914, pp. 14–23.

The converse is true of currents moving away from the equator or in the direction of the poles. These elementary facts explain why both the meteorological and the oceanic circulatory systems are clockwise in the northern hemisphere and counterclockwise in the southern hemisphere.

The primary geophysical results of the circumstances just cited are that in middle latitudes the movement of ocean currents along the east coast of both Americas is in the general direction of the poles, whereas on the west coast the flow is equatorward. It follows that in the Atlantic littoral region tropical or subtropical hydrographic conditions obtain through many degrees of latitude (roughly 60°), while in the Pacific littoral they are contracted to a breadth of barely 30° of latitude owing to the intrusion toward the equator of cool currents from both the north and the south. As a matter of fact, the only characteristically tropical or subtropical Pacific waters in contact with the coast of America lie in the narrow zone between the Gulf of Guayaquil (latitude 3° S.) and the Gulf of California.

The Humboldt Current

The Humboldt Current is a northerly branch of the Pacific Antarctic drift, and in both extent and influence it is perhaps the most remarkable of oceanic streams. It owes its origin chiefly to the prevailing westerly winds of high southern latitudes and to the meteorological whirl of the eastern South Pacific. It is particularly noteworthy for its sustained low temperature. The apparently anomalous circumstances were first noted by Alexander von Humboldt in 1802, when the great cosmographer observed surface temperatures of 59.9° F. at Callao in the early part of November—readings which were extraordinarily different from others taken in the outlying tropical Pacific. It has since been determined that the mean annual temperatures of waters close to the shore line of central Peru are, in fact, from 18° to 20° F. lower than the theoretical values for the latitudes.

The current laves the western coast of South America from a point somewhere south of 40° S., to the vicinity of the westernmost projection of the continent at Point Pariña (4° 40′ S.), whence the main branch sets west-northwestward, flows on both sides of the Galapagos Islands, and is lost beyond longitude 100° W. in the south equatorial drift.

It would seem that the current is most apparent, as a factor to be taken account of by navigators, after it departs from the South American coast. Between Cape Blanco and the Galapagos Islands, Fitzroy, commander of the *Beagle* "was set fifty miles to the west-northwest" in the twenty-four hours preceding his making the archipelago from the southeast.[4] In the same region Colnett "fell in frequently with streams of current, at least a mile in breadth, and of which there was no apparent termination. They frequently changed the ship's course, against her helm, half the compass, although running at the rate of three miles and an half an hour. . . . The

[4] Robert Fitzroy: Narrative of the Surveying Voyages of His Majesty's Ships Adventure and Beagle, 3 vols., London, 1839; reference in Vol. 2, p. 505, footnote.

froth and boil of these streams appear at a very small distance like heavy breakers."[5] Further evidence of the activity of oceanic circulation about the Galapagos is afforded by one of Fitzroy's observations, made in October, 1835, when surface temperatures on opposite sides of Albemarle Island were found to be respectively 80° F. and less than 60° F.[6]

In addition to the main or westerly branch of the Humboldt Current, a minor effluent, which turns northeastward after passing Point Pariña and flows along the Ecuadorian coast into the Bay of Panama, is apparent at certain seasons.

Thermal Characteristics of the Humboldt Current

Significant thermal features of the surface waters in the littoral portion of the current, with which this paper is concerned, are (1) relatively low temperatures in close proximity to the land, with rising temperatures off shore along lines perpendicular to the trend of the coast; and (2) extraordinary uniformity of temperatures throughout the greater part of the length of the current, a uniformity which is little affected by either latitude or season of the year. Both of these facts would of themselves strongly suggest that the low temperatures close to shore are due to upwelling from the "polar creep" rather than to the actual northward transportation of subantarctic surface waters. The conditions are totally unlike those of warm currents, such as the Gulf Stream and the Brazil Current, which undoubtedly carry identical masses of water for great distances. It must be borne in mind that oceanic streams of the latter type are in their entirety surface flows, which usually if not always rest upon layers of colder and denser waters.

The researches of McEwen[7] have made it clear that the low surface temperatures in the inshore areas of the California Current are due exclusively to upwelling of bottom water caused by the broad belt of northwesterly winds along the Pacific coast of North America. Such winds, acting upon a principle previously referred to, cause the moving surface water to swing gradually toward the right, or off shore, whereupon it is replaced by water from deeper layers. In like manner south of the equator an accelerated left-hand trend and continuous vertical circulation are caused in the Humboldt Current by steady southerly winds, parallel to the coast, which tend to force the surface water off shore at an angle of 45° from their path. For the same reason and also because the submarine slope of the continent shoulders off to seaward the warmer and lighter surface waters of a deep, impinging stream, the water closest to shore is the coldest. The steeper the coastal slope, the greater the reduction of surface temperature, for the narrower and more concentrated is the belt of upwelling bottom water.

[5] James Colnett: A Voyage to the South Atlantic and Round Cape Horn into the Pacific Ocean, London, 1798, pp. 45–46.

[6] Fitzroy, *op. cit.*, p. 505.

[7] G. F. McEwen: The Distribution of Ocean Temperatures along the West Coast of North America Deduced from Ekman's Theory of the Upwelling of Cold Water from the Adjacent Ocean Depths, *Internatl. Rev. der gesamt. Hydrobiol. und Hydrogr.*, Vol. 5, 1912, pp. 243–286.

During five months' field work in 1919 and 1920, the writer recorded upwards of 300 surface temperature observations in the Humboldt Current at points between Independencia Bay (14° 18′ S.) and the northern waters of Peru (4° S.).[8] Although many of the readings proved slightly higher than ranges obtained during the earlier and more extensive work of Coker,[9] the general conclusions of the latter were confirmed. These are (1) that only very slight latitudinal changes in the surface temperature of the inshore coastal water occur along the whole length of the Peruvian coast between Mollendo and Paita (1000 nautical miles) and (2) that the small observable variations are due chiefly to local influences and only in much slighter degree to seasonal conditions.

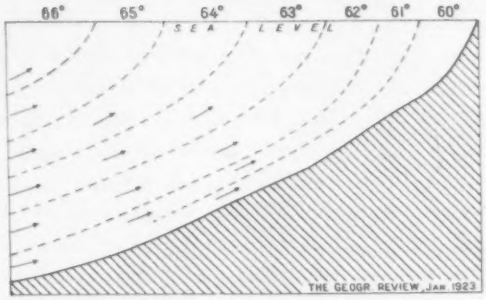

FIG. 1—Diagram illustrating the probable relation between the upwelling of bottom water and decreasing shoreward temperatures in the Humboldt Current (width of cross section approximately 10 sea miles). For a discussion of parallel conditions on the west coast of Africa see Alfred Franz: Beiträge zur Ozeanographie und Klimatologie der Deutsch-Sudwestafrikanischen Küste nach Beobachtungen von S. M. S. *Möwe*, *Archiv der Deutschen Seewarte*, Vol. 38, No. 1, 1920.

Earlier investigators[10] than Coker have established the fact that the uniform temperature conditions of the Peruvian coast are carried southward in the Humboldt Current at least as far as Valparaiso, Chile. It is in accord with the abyssal topography that the current, as characterized by upwelling waters, should begin near Valparaiso, for just south of that port the great bank on which Juan Fernandez lies extends to the westward more than twenty degrees of longitude.

TEMPERATURE FLUCTUATIONS IN THE CURRENT

Average temperatures within five miles of shore along the greater part of the coast of Peru range between about 58° F. (14.44° C.) and 64° F. (17.78° C.) throughout the year. At times, however, irregular variations are apparent locally, or even extensively, such changes being commonly attributed to a shifting of the course of the Humboldt Current, that is to influences which cause the stream to swing temporarily off shore. This assumed phenomenon, mentioned by Coker, is universally accepted as a fact in Peru. The alleged aberrations are recognized by the native fishermen through the effect upon

[8] The instruments used were among equipment generously supplied by the American Geographical Society and comprised United States naval thermometers (Fahrenheit) and specially constructed maximum and minimum thermometers of Six's type, all manufactured and calibrated by the Henry J. Green Co.

[9] R. E. Coker: Ocean Temperatures Off the Coast of Peru, *Geogr. Rev.*, Vol. 5, 1918, pp. 127–135.

[10] Otto Krümmel: Handbuch der Ozeanographie, 2nd edit., 2 vols., Stuttgart, 1907 and 1911; reference in Vol. 2, p. 715 (quoting observations by Capt. Paul Hoffmann).

J. Y. Buchanan: On the Similarities in the Physical Geography of the Great Oceans, *Proc. Royal Geogr. Soc.*, Vol. 8, 1886, pp. 753–770; reference on p. 765.

the catch of anchovies, bonitos, or other fishes;[11] and by the inhabitants of coastal towns through the effect upon climate. Exceptionally warm weather at Lima—such as obtained, for example, during part of the winter season (June–Sept.) of 1919—is credited in popular opinion to the retreat of the current from the coast.

It is the writer's belief that such phenomena are to be interpreted in another way. Many observers, from the days of Fitzroy to the present, have noted that an alteration or reversal or "set to southward" in oceanic circulation along the Peruvian coast is likely to occur from time to time and that such changes often coincide with or follow northerly winds. We have abundant evidence that the friction between atmosphere and hydrosphere produces a quick response. The normal conditions in the Peruvian littoral are due to prevailing southerly winds which, except for the well known day and night swing, vary remarkably little from one year's end to another. When, however, this uniform meteorological control temporarily gives way to northerly winds there is a tendency to drive the warmer offshore surface waters towards the land at an angle of 45°, and an immediate effect is seen in the partial or complete cessation of upwelling. Moreover, the fact that the calculated eastward pressure of the Humboldt Current is literally blocked by the half-submerged Andean wall, makes the explanation just given more satisfactory than the pure assumption that the current sometimes shifts its course to westward, an assumption which has perhaps been made through false analogy with the very different hydrographic system of the Atlantic Gulf Stream.

The Countercurrent

Paracas Peninsula and San Gallan Island (13° 50′ S.), which project into the Pacific at the "bend" of the Peruvian coast, appear to mark the boundary between two littoral regions of somewhat different oceanographic character. To the southward of this point conditions in the coastal water which depend in the main upon constant upwelling attain their maximum of uniformity;[12] to the northward the generally stable equilibrium is at times disturbed not only by such relatively insignificant fluctuations as have already been referred to but also by influences of a more profound nature. Especially to the northward of Salaverry (8° 13′ S.), seasonal influxes of warmer waters from equatorial regions sometimes raise the temperatures considerably above normal over wide areas. The advancing tropical waters form an indubitable countercurrent, which is known to the inhabitants of the coast as *El Niño* (The Child) because it often becomes evident about Christmas time.

This countercurrent, which Coker has described,[13] made its appearance at the time of the writer's field work among the northern Peruvian islands, in January, 1920. On the second of this month, the average of 11 surface tem-

[11] Coker, Ocean Temperatures, p. 132.

[12] Coker, *ibid.*, p. 133, found absolutely no seasonal variation in surface temperatures on an exposed shore at Mollendo.

[13] *Ibid.*

peratures taken during a period of six hours off Pacasmayo (7° 24′ S.) was 60.4° F. (15.78° C.). Two weeks later (Jan. 15 and 16), however, 17 temperatures obtained during 28 hours in the same area averaged approximately 69° F. (20.56° C.). The explanation is that the warm waters of *El Niño* had overflowed the northern end of the Humboldt Current in the interim.

The countercurrent has long been an object of interest to navigators and other observers in Peru. It has been discussed in many issues of the *Boletín* of the Geographical Society of Lima, beginning with the first volume in 1892, and its imperfectly known characteristics are recorded in the Peruvian *derroteros*, or pilot books, of Melo and Stiglich. Stiglich[14] and other Peruvian writers infer that the countercurrent proceeds from the river Guayas (emptying into the Gulf of Guayaquil) in freshet season, but the volume of water in this source would be insufficient to account for the observed effects. The current should be attributed rather to the periodic even though variable changes in barometric pressure which occur when the belt of maximum insolation is well south of the equator.

Aside from the previously noted increase of ocean temperatures off Pacasmayo, the writer's field notebook contains numerous inferential references to the southward extension of *El Niño* in January, 1920. Among these are the following:

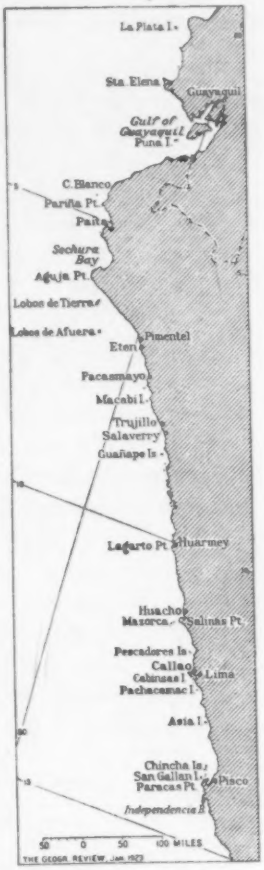

FIG. 2—Sketch map of the Peruvian coast to show localities mentioned in the text.

1. The captain of the Chilean steamship *Huasco* testified that on January 10, while passing northward between the Lobos Islands (6° 27′—6° 56′ S.), the course of his vessel was perceptibly affected by a strong northwestward set of the Humboldt Current. On the following morning, however, off Sechura (5° 35′ S.) he encountered an adverse current, flowing southward past Paita and noticeable thereafter along the entire length of the coast of Ecuador.

2. On January 24, near the Guañape Islands (8° 35′ S.), when the temperature of the surface of the ocean was 67.5° F. (19.72° C.), or from 6 to 7 degrees higher than it had been on January 1, many *mantas*, or large rays,[15] were seen leaping from the water into the air. Ordinarily these somersaulting fishes are to be observed only in the extreme northern waters of Peru, north of Point Pariña. Their jumping is a common phenomenon in the tropical ocean off Ecuador. Near La Plata Island (1° 16′ S.), for instance, the writer noted them in great abundance on September 5, 1919, and again in early February, 1920. The commander of the *Huasco* (Captain Herbert Gregory) maintained that the migration of the jumping rays down the Peruvian coast as far southward as Salaverry and the Guañapes is always coincident with other manifestations of *El Niño*.

[14] Germán Stiglich: Derrotero de la costa del Perú, Lima, 1918, p. 8.

[15] It has not been possible, in default of specimens, to identify this large and conspicuous species.

3. On January 24 large numbers of dead boobies, of a species (*Sula variegata*) which lays its eggs on the ledges of the Peruvian islands, were observed along scummy drift lines extending for miles to the *southward* of Macabi and Guañape Islands. Ordinarily the lines of foam produced by the rocks and islets of the coast stretch away to the northward, and the dead birds, chiefly nestlings which have fallen from the cliffs, are carried rapidly in the same direction by the flow of the Humboldt Current.

The problems of the countercurrent have recently been attacked by Lavalle[16] in relation to a peculiar pandemic disease of the Peruvian guano birds, which he has diagnosed as "aspergilosis." This malady appears at intervals of years, and its visible effects have been mentioned from early times in maritime books and in the logs of ships.[17] During the outbreaks countless numbers of the littoral sea birds die upon the breeding grounds or the water, their bodies subsequently washing ashore by thousands and strewing the beaches for miles.

Lavalle attributes the disease of the birds, together with the meteorological and hydrographic changes which ordinarily precede its appearance, to the southward advance of *El Niño*. After calling attention to the fact that the temperature of the tropical current is normally not less than 5° C. higher than that of the most northerly waters of the Humboldt Current near Cape Blanco, he remarks that fish and nearly all forms of plankton are killed by abrupt temperature changes of this magnitude. Correlating his hypothesis with phenomena observed in 1917 or recounted in the literature of the subject, Lavalle evolves a rational exposition of the relation between the advance of the countercurrent, accompanied by changes in ocean temperature, atmospheric humidity, etc., and its secondary effects such as the mortality of fish and birds and the irruption of the renowned "Callao Painter." The latter phenomenon, which is known also as "*aguaje*" and "*agua enferma*," is in general confined to the stretch of water between Paita (5° 05′ S.) and Pisco (13° 43′ S.), and more especially to that between Pacasmayo (7° 24′ S.) and Callao (12° 04′ S.). Its immediate cause, according to Lavalle, is the accumulation of enormous quantities of plankton, killed by the rise of ocean temperatures, in protected localities where, owing to the coastal contour, centripetal eddies exist. The bay of Callao is one of several such places. Here the penetration of the sun's rays into the shallow water hastens decomposition of the mass of organisms, which are so thick as to discolor the ocean. Active production of hydrogen sulphide and other gases results, and for a while the affected areas become as toxic to life as the depths of the Black Sea.[18]

[16] J. A. de Lavalle: Informe preliminar sobre la causa de la mortalidad de las aves ocurida en el mes de marzo del presente año, *Memoria de la Compañía Administradora del Guano*, Vol. 8, 1917, pp. 61–84.

[17] Rear Admiral C. F. Goodrich, U. S. N., has informed the writer that on August 10 and 11, 1899, the U. S. S. *Newark*, under his command, passed for three hundred miles through areas of dead pelicans and other sea birds in the northern waters of Peru. The position of the vessel at noon of August 11 was 5° 07′ S. (off Paita), 45 miles from the coast.

[18] W. E. Allen (Problems of Floral Dominance in the Open Sea, *Ecology*, Vol. 2, 1921, pp. 26–31) has recently directed attention to the extreme sensitiveness of diatoms and other marine organisms to changes in salinity, light, density, temperature, and hydrogen-ion concentration and to the possibilities of sudden, excessive, and finally fatal development of one or more species of organisms to the exclusion of other related or competing forms.

It is easy to understand the effect of the countercurrent upon the piscivorous sea birds of the Peruvian coast. Lavalle[19] states that in March, 1917, before *El Niño* had become perceptible about the Guañape Islands but after it had been reported farther to the northward, great numbers of pelicans arrived at Guañape, having abandoned their feeding grounds in the neighborhood of the Lobos Islands at the approach of the warmer water. Shortly afterwards the total sea bird population of Cabinsas (12° 09′ S.) fled in like manner from their threatened territory and settled at Pachacamac and Asia Islands (respectively 12° 19′ S. and 12° 48′ S.). The ultimate fate of all birds which do not migrate in this way to the "safe" waters of the southern half of the Peruvian coast is a loss of food supply and a lowering of vitality which renders the victims an easy prey to infectious pulmonary disease caused by a fungus, *Aspergillus fumigatus*, or by related organisms. If the countercurrent continues its advance as far south as the Pisco Bay region, hundreds of thousands of the priceless guano birds may perish before the rhythms of nature restore favorable life conditions throughout the field of the Humboldt Current.

Evidence as to the Prevailing Uniformity of Hydrographic Conditions in the Current

It should not be forgotten that cataclysmic disturbances, such as have just been described, obtain at only rare intervals and are the exception rather than the rule. Extraordinary uniformity is, after all, the outstanding hydrographic feature of the Peruvian littoral. The very fact that relatively slight fluctuations toward the border line of a distinct oceanic region so profoundly affect the whole life association of the Humboldt Current is in itself evidence that this life must have become thus inflexibly adapted through the long duration of substantially invariable conditions.

Essential uniformity in the Humboldt Current is indicated by temperature data alone, but confirmation drawn from a study of the diatomaceous flora may serve to emphasize the prevailing physical stability.

Townet collections obtained by the writer, together with samples of bird guano of various ages and from several different islands in the Humboldt Current, were submitted to Dr. Albert Mann, of the Carnegie Institution, who has reported by letter upon their diatom content. Some of the guano samples were excavated in deep, so-called "fossil" beds on Lobos de Afuera and Lobos de Tierra, where it must have been deposited so long ago that its age can be reckoned only by centuries. Both the ancient and the recent guano, as well as the plankton collected in townets along some 700 miles of the coast, proved to be rich in diatoms. The point of particular interest is that all of this material, whether collected in October or in February, whether at Independencia Bay (14° 15′ S.) or near the Lobos Islands (7° S.), whether captured in the haul of a silk net or extracted from guano deposited by four

[19] Informe preliminar, p. 22.

or more species of sea birds an hour, a month, a year, or five hundred years before—contained the same characteristic species of diatoms. Certain prevalent forms, such as *Skeletonema costatum*, *Grammatophora marina*, and various species of the genus *Coccinodiscus*, appear in nearly all of the diverse samples which were analyzed. Dr. Mann writes:

> There is considerable similarity between the different guanos in the species of diatoms they contain. In fact no sample stands out as radically unlike the rest, as would be the case were the plankton flora of the ocean a totally dissimilar one at any of the periods of time represented by any one of the samples. This in itself is interesting; because it is no infrequent thing for the diatom flora of a given locality to be strikingly dissimilar on two successive years. Thus the diatoms of Woods Hole, Massachusetts, were very different in 1920 from those found in 1919.[20]

Temperature Ranges in the Humboldt Current

The lowest surface temperature recorded by the writer at stations between Independencia Bay and the Gulf of Guayaquil was 58° F. (14.44° C.), a figure obtained at various times and places. In order to indicate the constancy of upwelling along a great extent of coast, it will be useful to cite the entire list of readings of 60° F. (15.56° C.) or lower.

The lowest temperature readings were obtained close to mainland or insular shore lines and in situations open to free circulation such as the *boquerones* or straits south of Callao and Pisco, the exposed southern entrance of Independencia Bay, etc. In passing from the sheltered waters of Pisco Bay through the constricted *boqueron* which separates Paracas Peninsula from San Gallan Island, surface temperatures in November, 1919, were found to decrease ten degrees Fahrenheit, or from 68° F. (20° C.) to 58° F. (14.44° C.).

Distance from the land, or in any direction away from an exposed islet in the Humboldt Current, is usually concomitant with increase of surface temperature. When traveling parallel with the mainland coast, a mile or more off shore, an observer finds that water temperatures are likely to be lower abreast of a projecting headland than they are off a bight. In short, the lines of equal temperature follow the turnings of the coast line, and a boat bound along shore repeatedly cuts the isothermic curves. Such observations indicate that the upwelling waters are being continually deflected to seaward as they strike exposed bottom slopes of the continental shelf.

The relation between temperature and distance from the Peruvian coast is well shown in Tables II–IV.

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[20] More recently Albert Mann (The Dependence of the Fishes on the Diatoms, *Ecology*, Vol. 2, 1921, pp. 79–83) has published notes which, by contrast, serve to stress still further the perhaps unique uniformity of the diatom flora in waters along the coast of Peru. Referring to conditions which hold for most parts of the world, he writes that there are clearly marked zonal and local diatom floras and that great variation in the constitution and abundance of this element of the plankton occurs from year to year. "Thus the diatom combination of Beaufort, N. C., is easily distinguished from that of Woods Hole, Mass., while that found along the shores of Florida is even more dissimilar." It may be added that the Peruvian coast line, where such variations are not found, is not greatly shorter than the Atlantic coast of the United States.

TABLE I—TEMPERATURE READINGS OF 60°F. (15.56°C.) OR BELOW

DAY	HOUR	PLACE	TEMPERATURE	
			°F.	°C.
Oct. 8	9 A. M.	Huacho Bay	59.5	(15.28)
	10 A. M.	Huacho Bay	59.6	(15.33)
	1 P. M.	N. end of Salinas Promontory	59.0	(15.00)
	1:30 P. M.	N. E. of Mazorca Island	59.8	(15.44)
16	12 M.	Chincha Is. (Central I.)	58.0	(14.44)
	6 P. M.	Chincha Is. (Central I.)	59.1	(15.05)
17	8 A. M.	Chincha Is. (Central I.)	60.0	(15.56)
	1 P. M.	Chincha Is. (South I.)	59.0	(15.00)
18	8 A. M.	Chincha Is. (Central I.)	60.0	(15.56)
19	10:20 A. M.	N. W. of Paracas Point	59.2	(15.11)
	10:55 A. M.	½ mile N. of Paracas Point	60.0	(15.56)
Nov. 10	7:45 A. M.	Chincha Is. (Central I.)	60.0	(15.56)
	8:07 A. M.	Chincha Is. (Central I.)	59.4	(15.22)
	9:10 A. M.	Point Lastre, Paracas Bay	59.6	(15.33)
15	11:40 A. M.	N. W. of Paracas Point	58.0	(14.44)
	12:10 P. M.	E. of San Gallan Island	58.0	(14.44)
	12:35 P. M.	Boqueron of San Gallan I.	58.5	(14.72)
15–19		Independencia Bay (minimum tube)	58.8	(14.89)
26	10:25 A. M.	N. bight of San Gallan I.	60.0	(15.56)
Dec. 12	11:50 A. M.	Callao Bay	59.8	(15.44)
15	8:15 A. M.	Pescadores Island	59.5	(15.28)
	8:30 A. M.	Gallinazo Islet, Pescadores group	60.0	(15.56)
Jan. 2	1:10 P. M.	1 mile off Pacasmayo	59.8	(15.44)
	1:18 P. M.	¼ mile off Pacasmayo pier	59.5	(15.28)
2, 3		Pacasmayo anchorage (minimum tube)	58.2	(14.56)

TABLE II—DECREASING TEMPERATURES OBTAINED WHILE BOUND TOWARD SHORE AT HUARMEY (10° 06′ S.), DEC. 30, 1919

10:30 A. M.	10 miles S. W. of Lagarto Head	67.0° F.	(19.44° C.)
11:30 A. M.	8 miles W. by S. of Lagarto Head	65.0	(18.33)
12:30 P. M.	5 miles off Lagarto Head	63.8	(17.67)
1:25 P. M.	Rounding Lagarto Head (entrance to Huarmey)	61.6	(16.44)

TABLE III—DECREASING TEMPERATURES OBTAINED WHILE APPROACHING LOBOS DE TIERRA FROM THE SEAWARD SIDE, JAN. 6, 1920

12:05 P. M.	8 miles from Lobos de Tierra	69.0° F.	(20.56° C.)
1 P. M.	4 miles from Lobos de Tierra	68.1	(20.05)
1:50 P. M.	2 miles from Lobos de Tierra	67.7	(19.83)
2:30 P. M.	1 mile from Lobos de Tierra	66.0	(18.89)
3:20 P. M.	At anchor, Caleta de Cherra	65.5	(18.61)

It would appear that Lobos de Tierra, the largest of the Peruvian islands, simulates the continent in producing upwelling from lower layers of water.

On January 15 and 16, 1920, after the mingling waters of *El Niño* had raised the general level of surface temperatures off northern Peru, a series of 17 readings, taken along an oblique line across the normal path of the Humboldt Current, still showed a gradual decrease from 70.2° F. (21.22° C.) one-half mile east of Lobos de Tierra to 66.5° F. (19.17° C.) near the end of the pier at Eten (6° 56′ S.).

TABLE IV—INCREASING TEMPERATURES OBTAINED WHILE BOUND FROM PACASMAYO TO LOBOS DE AFUERA ISLAND, JAN. 3 AND 4, 1920

6 P. M.	Pacasmayo (28 hour minimum)	58.2° F.	(14.56° C.)
9 P. M.	11 ? miles off shore	61.5	(16.39)
6:30 A. M.	21 ? miles E. S. E. of Lobos de Afuera	66.2	(19.00)
7:10 A. M.	18 ? miles E. S. E. of Lobos de Afuera	66.5	(19.17)
7:35 A. M.	16 ? miles E. S. E. of Lobos de Afuera	66.7	(19.28)
8:45 A. M.	12 miles E. by S. of Lobos de Afuera	67.0	(19.44)
9:30 A. M.	8 miles E. by S. of Lobos de Afuera	67.2	(19.56)
10:20 A. M.	4 miles E. by S. of Lobos de Afuera	68.0	(20.00)
10:35 A. M.	3 miles E. by S. of Lobos de Afuera	68.0	(20.00)
10:50 A. M.	1 mile from Lobos de Afuera	69.0	(20.56)
11 A. M.	Anchorage ¼ mile from shore	68.7	(20.39)

Again, on February 3–7, 1920, temperatures of 66.2° F. (19.00° C.) close to the beach at Salaverry increased steadily off shore and to the northward, reaching 75.2° F. (24.00° C.) near Point Pariña (4° 40′ S.) on February 4, 79° F. (26.11° C.) off the Gulf of Guayaquil, and 80° F. (26.66° C.) off Point Santa Elena (2° 12′ S.), Ecuador. The last two figures are close to the yearly mean temperature not only of the Ecuadorian littoral but also of the offshore waters of the southern tropical Pacific, outside the zone of upwelling, at least as far to the southward as the latitude of central Peru (e. g. 14° S.). Captain Paul Hoffmann[21] found, for example, that surface temperatures of 64.9° F. (18.3° C.) at Callao rose progressively to 81.0° F. (27.00° C.) at 135 nautical miles from shore. Data from the *Albatross* records of 1904, quoted in substance by Coker,[22] further support the conclusions which must be drawn.

By bringing together available thermometric readings accompanied by exact locations the writer has computed that 1.5° F. represents an approximation of the average rise in temperature per nautical mile from the coast line of central and northern Peru. The rate would not, of course, apply during an active advance of the countercurrent. Moreover, because of the paucity of the observations and the fact that the ratio between temperature and distance is unlikely to be constant across the full width of the Humboldt Current, the figure can be considered as only suggestive.

[21] Paul Hoffmann: Zur Mechanik der Meeresströmungen an der Oberfläche der Oceane, Berlin, 1884, p. 76.
[22] Ocean Temperatures, p. 130.

As regards normal maximum temperatures in the Humboldt Current, the data are rather difficult to interpret because most of the high readings can be attributed to special circumstances. Great variation occurs, as Coker has pointed out, in enclosed bays, where eddies form and where the same masses of shallow water lie until they can be warmed by the sun. Doubtless the best conception of average high temperatures will be derived from considering a series of records from exposed situations, such as the Chincha Islands or the Guañape and Lobos Islands before the surrounding waters had been warmed by the countercurrent of January, 1920.

Ranges of surface temperatures at fixed points, with data on diurnal and nocturnal variation, are given in Table V, which comprises readings obtained with both the Six's and the naval thermometers.

TABLE V—TEMPERATURE RECORDS IN THE HUMBOLDT CURRENT, OCTOBER, 1919—FEBRUARY, 1920

DATE	PLACE	RECORD	LOWEST		HIGHEST	
			°F.	°C.	°F.	°C.
1919						
Oct. 11	Central Chincha Is.	24 hours	63.2	(17.3)	65.0	(18.3)
Oct. 13	Central Chincha Is.	48 hours	60.8	(16.0)	61.2	(16.2)
Oct. 14	Central Chincha Is.	22 hours	59.0	(15.0)	63.7	(17.6)
Oct. 16	Central Chincha Is.	2 readings, 12 M., 6 P. M.	58.0	(14.4)	59.1	(15.0)
Oct. 17	Central Chincha Is.	3 readings				
Oct. 18	Central Chincha Is.	4 readings, 8 A. M., 3 P. M.	60.0	(15.5)	63.1	(17.3)
Oct. 21	Central Chincha Is.	4 readings, 8 A. M., 3 P. M.	63.7	(17.6)	64.9	(18.3)
Oct. 24	Central Chincha Is.	2 readings, 8 A. M., 6 P. M.	63.0	(17.2)	63.8	(17.7)
Oct. 25	Central and North Is. (4 stations)	4 readings, 8 A. M., 10 A. M.	61.4	(16.3)	63.9	(17.7)
Oct. 26	Central Chincha Is.	3 readings, 8 A. M., 1 P. M.	62.0	(16.7)	63.3	(17.4)
Nov. 22	Central Chincha Is.	4 readings, 6:30 P. M., 2:30 P. M.	64.5	(18.0)	65.3	(18.5)
Nov. 23	Central and North Is. (6 stations)	6 readings, 9:30 A. M., 8:30 A. M.	62.8	(17.1)	63.8	(17.7)
Nov. 26	North Chincha Is.	48 hours	60.8	(16.0)	62.3	(16.8)
Nov. 15–19	Independencia Bay	84 hours	58.8	(14.9)	63.6	(17.5)
Dec. 28	Palominos Rocks (off Callao)	3 readings, 2:30 P. M., 7:15 P. M.	62.0	(16.7)	63.0	(17.2)
1920						
Jan. 1	South Guañape Is.	24 hours	60.8	(16.0)	63.3	(17.4)
Jan. 3	Pacasmayo (anchorage)	28 hours	58.2	(14.5)	60.8	(16.0)
Feb. 1	Bay of Callao	2 readings, 11 A. M., 6:30 P. M.	63.6	(17.5)	64.0	(17.8)

Records made with the maximum-minimum thermometer at Independencia Bay and elsewhere show that the average of maxima for the day period (7 A. M.—7 P. M.) is about 2° F. higher than the average maxima for the

night period. For additional data on these very slight changes, which are a further indication of upwelling, Coker's paper should be consulted.

Readings of from 68° F. (20.00° C.) to 69° F. (20.56° C.) were made in parts of the Bay of Pisco during October and November; but these were in every case explained by the discharge of freshet waters from the Pisco River, which turned toward the left or south from its mouth and formed a counter-clockwise eddy distinguishable from the bay water by color as well as by temperature. Similar phenomena, with increases of temperature amounting to 6° or 7° F., were noted on February 3, off the mouth of the River Chicama, north of Salaverry. With these exceptions, no temperature higher than 66° F. (18.89° C.) was obtained within twelve miles of the Peruvian mainland until after the first signs of *El Niño* in January. It need hardly be added, however, that high temperatures were recorded everywhere *off shore* during the whole period of field work.

The Breadth of the Humboldt Current as Compared with That of the California Current

Stiglich[23] states that the mean breadth of the Humboldt Current along the coast of Peru is about 150 miles, a figure which, from a navigator's point of view, is doubtless roughly correct. We have records of very few temperature observations along lines extending across stream to the warm outlying ocean, but the *Albatross* tables[24] and the readings of Captain Hoffmann show that the belt of cool water is extraordinarily narrow when compared with conditions in the corresponding region of the North Pacific. The fact is confirmed, furthermore, by studies of the biota of the Humboldt Current, for the characteristic algae, as well as the invertebrates, fishes, and higher forms of life, are all confined to waters near the coast.[25]

Recent investigations in the California Current by the hydrographic staff of the Scripps Institution for Biological Research reveal an order which is at striking variance with that of the Peruvian littoral. The California Current, at least off the southern Pacific coast of the United States, is a remarkably broad stream, the effects of which can be detected a thousand or more miles from shore. Again, the zone of maximum upwelling, and consequently of lowest temperatures and greatest profusion of marine life, lies far off the coast, in sharp contrast with the respective conditions off the west coast of South America. Michael[26] sums up the data for the California Current as follows:

> Between July, 1917, and June, 1918, and within a strip of water extending approximately one hundred twenty-five nautical miles seaward from Point Fermin, volume of phytoplankton, collected in vertical hauls from 200 meters to the surface, when corrected for the effect

[23] *Op. cit.*, p. 8.

[24] *Bur. of Fisheries Doc. No. 604*, 1906, pp. 54–58.

[25] Estimates of the breadth of the Humboldt Current as deduced from meteorological observations conform with those based upon other data. Cf. Mark Jefferson: The Rainfall of Chile, *Amer. Geogr. Soc. Research Ser.*, No. 7, 1921, p. 8.

[26] E. L. Michael: Effect of Upwelling Water upon the Organic Fertility of the Sea in the Region of Southern California, *Bernice P. Bishop Museum Special Publ. No. 7, Part II*, 1921, pp. 555–595; reference on p. 589.

of season, increased, on the average, from a minimum nearest shore to a maximum about seventy miles off and then decreased with further increase in distance.

The surface temperature, simultaneously observed at the places phytoplankton was collected, decreased on the average, when corrected for the effect of season, from a maximum nearest shore to a minimum about seventy miles off and then increased with further increase in distance.

The explanation of these contrasts, which are at first puzzling, is doubtless to be found in the very different relative trends of the Pacific coast lines of North and South America and in the dissimilar topography of the respective continental shelves. A glance at the map, especially at a globe, will show the great divergence of the coasts of the Californias from the course of the clockwise, or right-hand, southward-flowing current. The coast of Peru, on the contrary, trending sharply to westward from near the Chilean border, extends far into the ideal course of the Humboldt Current and forces the latter to become an actively impinging stream until it has passed the end of the continental buffer at Point Pariña. A bathymetric chart throws further light on factors which produce dissimilar zones of upwelling in the two hemispheres. The South American coastal shelf, between Valparaiso and northernmost Peru, is narrower, more steeply terraced, and far less irregular along its outer border than the west coast of North America. Since upwelling is most pronounced where the transition from deep to shallow water is most abrupt, the reason for the low ocean temperature very close to the Peruvian coast is obvious.

The Velocity of the Humboldt Current

Existing data on the rate of flow of the Humboldt Current have been derived mostly from the reports of seafarers whose reckonings have been thrown out by this disconcerting and largely unmeasurable factor. The pilot books rather vaguely assign a velocity of "15 miles per day," a "general set of ½ to 1 knot," "a speed of one mile per hour throughout the year," etc. The effect of the flow is, of course, universally recognized as favorable or adverse in navigation, depending upon the direction of a voyage.[27]

The writer made numerous attempts to measure the rate of flow with a Gurley current meter. Many of the trials were fruitless because the revolutions of the instrument, suspended from one to fifty feet beneath the surface of the sea, were affected by unavoidable jerky movements of an anchored trawler or schooner. The following three readings, each based upon from 6 to 26 counts, were made under generally favorable circumstances. The rates, especially the second and the third, are believed to be not far from approximations of the truth. They are offered here for whatever they may be worth.

1. ½ mile west of South Chincha Island, Oct. 17, 1919. Average of 6 measurements of one minute each. Current of 1.4 statute miles per hour, setting toward the coast (considerably to east of north). The sea was choppy, probably causing an acceleration of the

[27] Coker, Ocean Temperatures, p. 132.

beats of the instrument, so that this reading is considered less dependable than those which follow.

2. Middle of southern entrance of Independencia Bay (Serrate Channel), Nov. 16, 1919. Average of 17 measurements of one minute each. Current of .64 statute miles per hour, setting 45° west of north. The ocean was calm and the station fully exposed to the movement of the current. The beats of the electric indicator were regular, and all indications are that the computation is reliable.

3. 250 yards east of the south point of South Guañape Island, Jan. 6, 1920. Average of 26 measurements of one minute's duration. Current of .7 statute miles per hour, setting 30° west of north. Ocean calm; open sea toward the source of the flow. This is probably the least inaccurate of all the records.

The average of the three velocities is .91 statute miles per hour. The writer has no data as to a possible tidal influence in any of the measurements, but it is not likely to have been significant.

Captains of *caleteras*, or coastwise steamers which call at all the Peruvian ports, informed the writer that the current is a factor to be seriously considered in steamship navigation only in two parts of their route: the first along the southerly coast of Peru, northward from Mollendo, and the second on the reaches between Eten and Point Aguja, in the north. In the latter region, according to the testimony of one captain, the stream frequently maintains a northwesterly rate of one knot for days together. These reports are in harmony with theory, for we might expect the maximum rate of flow where the coast trends to westward and thus deflects the centrifugal pressure.

Ecology of the Humboldt Current

The geophysical characteristics of the Peruvian littoral offer favorable life conditions for a great profusion of marine organisms. In the first place, the low salinity, due to upwelling of water more or less polar in origin, and more particularly the low temperature facilitate absorption of atmospheric gases and the retention of those produced by the metabolism of oceanic plants and animals. Again, low salinity makes possible the solution or suspension of increased proportions of silica, which, together with nitrogen compounds and phosphoric acid, is among the minimal nutritional elements upon which all life in the sea is ultimately dependent.

The reduction of buoyancy due to lowered salinity is more than made up by the increased viscosity resulting from low temperature, viscosity being the most important property of sea water for inhibiting the descent of minute forms of life to unfavorable levels. Other things being equal, water at a freezing temperature offers twice as much resistance against sinking as water at 77° F.

Finally, the stable temperature of the littoral water, except during the rare invasions of *El Niño*, results in life conditions which are far more uniform than along most of the temperate Atlantic coasts where marked periodicity is the rule.

The organic source of all food in the sea, for abyssal creatures as well as those of the surface strata and of the atmosphere above, is the microscopic

plant life, comprising mostly the brown algae (Phaeophyceae), which, obtaining their nitrogen directly from nitrates in the circulation, build up tissue that becomes the food of copepods and other crustaceans, certain fishes, etc., which, in their turn, are devoured by higher animals. In the presence of sunlight the microscopic plants, moreover, assimilate the carbon of carbonic acid and restore the oxygen to solution, thus bettering the conditions for animal life. Under optimum circumstances, the algae may number as many as 40,000 individuals per liter of ocean water.[28] They exist principally in a layer within fifty fathoms of the surface, though they may sometimes penetrate three or four times as far, and their dead remains are uninterruptedly settling into the lightless depths. But vertical circulation, which is continually bringing masses of deeper water to the surface along the inner border of the Humboldt Current, is thereby steadily restoring nutritive substances, in the form of decomposition products such as ammonia, to the upper layer of the ocean. Here, if not directly available for the algae, they may be utilized by nitrifying bacteria and worked over into material which enables the profuse development of plant life to go on. The quantity of phytoplankton varies directly with the amount of upwelled water, and for this reason the marine areas in which ascending currents occur are favored with the most prolific efflorescence of both microörganisms and higher creatures. On the other hand, surface life is always least abundant in anticyclonic or dead-water regions, like the Atlantic Sargasso Sea, where the surface layers continually sink.

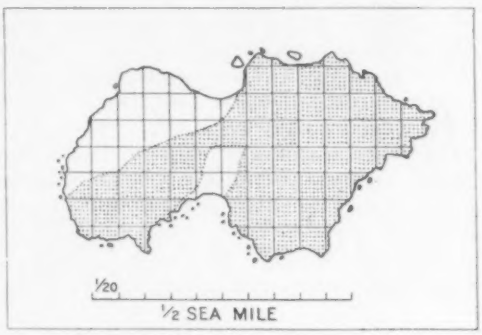

FIG. 3—Sketch map of Central Chincha Island, Pisco Bay, showing in shading the area occupied by *guanayes* or white-breasted cormorants (*Phalacrocorax bougainvillei*) on January 1, 1913. Copied from a manuscript report by H. O. Forbes. A conservative estimate would place the total bird population, young and adult, at 5,600,000. Not less than a thousand tons of fish per day would be required to sustain such a colony.

It has been suggested that another possible effect of the upwelling of cold bottom waters results from the fact that even moderately low temperatures inhibit the activity of denitrifying bacteria.[29] It has been shown, however, that in the presence of sufficient free oxygen these bacteria never exhibit their power of denitrification, even though they may multiply indefinitely.[30] In view of the favorable conditions for the production and retention of oxygen in the cool waters off the west coast of South America, it appears that the suppression of the denitrifying bacteria is here of no great consequence as a partial explanation of the abundant life.

[28] W. E. Allen: Observations on Surface Distribution of Marine Diatoms between San Diego and Seattle, *Ecology*, Vol. 3, 1922, pp. 140–145.

[29] Cf. H. F. Osborn: The Origin and Evolution of Life, New York, 1917, p. 91.

[30] John Murray and Johan Hjort: The Depths of the Ocean, 1912, pp. 369, 370.

Abundance of Life in the Humboldt Current

Thirty-five years ago Buchanan wrote, "No waters in the ocean so teem with life as those on the west coast of South America.[31] More recent investigations have borne out this statement. Space cannot be spared for lengthy quotations relating to the lower animals, but Bigelow's remarks[32] are doubly interesting in that they refer both to the abundance of life in the current and to the contrasting conditions in the warm water areas beyond. He writes:

> I cannot pass over without mention the extraordinary richness of the Humboldt Current in pelagic life of all kinds; a richness which has already been noted in the account of the general oceanographic features of the Eastern Tropical Pacific by its [the expedition's] leader, who speaks of "such masses of Salpae, of Cytaeis, or Cymbulia, or swarms of other pelagic animals as to make a thick soup" . . ., and of enormous quantities of copepods, schizopods, Doliolum, and Medusae. Nor can I omit to recall the discovery, immediately to the west and southwest of the Current, of an area as barren in all forms of life, bottom as well as pelagic, as the latter is rich. Thus "As soon as we ran outside of this [the Humboldt Current] the character of the surface fauna changed; it became less and less abundant as we made our way to Easter Island, the western half of the line from Callao becoming gradually barren." On entering the current again from the barren area the reverse change was equally striking.

An impressive picture of the unparalleled profusion of organisms, particularly of fishes and birds, has been given in the publications of Coker, Forbes, Lavalle, Chapman, Murphy, and other writers.[33]

Coker, for example, records the following:

> In contrast to the barrenness of the coast [of Peru] there is a peculiar wealth of certain forms in the open ocean. The great red seas, formed sometimes, at least, of myriads of microscopic dinoflagellates, are of common occurrence. . . . Sometimes, too, great areas of the surface of the sea are reddened by the vast numbers of small crustacea (*Munida*),

[31] Buchanan, *op. cit.*, p. 766.

[32] H. B. Bigelow: Reports of the Scientific Results of the Expedition to the Eastern Tropical Pacific, in Charge of Alexander Agassiz, . . . XVI, The Medusae, *Memoirs Museum of Comp. Zoöl. at Harvard College*, Vol. 37, 1909, p. 222.

[33] The more important references follow:

R. E. Coker: Numerous articles in the *Bol. Minist. de Fomento*, Vols. 5 to 7, 1907–1909, Lima.

Idem: Regarding the Future of the Guano Industry and the Guano-Producing Birds of Peru, *Science*, No. 706, Vol. 28, 1908, pp. 58–64.

Idem: The Fisheries and the Guano Industry of Peru, *Bull. Bur. of Fisheries*, Vol. 28, 1908, Part I, pp. 333–365.

Idem: Habits and Economic Relations of the Guano Birds of Peru, *Proc. U. S. Natl. Museum*, Vol. 56, 1920, pp. 449–511.

Idem: Peru's Wealth-Producing Birds, *Natl. Geogr. Mag.*, Vol. 37, 1920, pp. 537–566.

Idem: An Illustration of Practical Results from the Protection of Natural Resources, *Science*, No. 1370, Vol. 53, 1921, pp. 295–298.

H. O. Forbes: The Peruvian Guano Islands, *The Ibis* (10), Vol. 1, 1913, pp. 709–712 (under "Notes and Discussion").

Idem: Puntos principales del informe presentado al supremo gobierno por el ornitólogo Dr. H. O. Forbes, *Memoria de la Compañia Administradora del Guano*, Vol. 5, 1914, pp. 57–105, Lima.

Idem: Notes on Molina's Pelican, *The Ibis* (10), Vol. 2, 1914, pp. 403–420.

J. A. de Lavalle: Informe preliminar sobre la causa de la mortalidad de las aves ocurida en el mes de marzo del presente año, *Memoria de la Compañia Administradora del Guano*, Vol. 8, 1917, pp. 61–84, Lima.

Idem: Estudio sobre los factores que influyen sobre la distribucion de los nidos de las aves productoras de guano, *ibid.*, 1918, Vol. 9, pp. 207–213.

F. M. Chapman: Notes from a Traveler in the Tropics, III, *Bird-Lore*, Vol. 21, 1919, pp. 87–91.

R. C. Murphy: The Seacoast and Islands of Peru, *Brooklyn Museum Quart.*, Vol. 7, No. 2, 1920 to Vol. 9, No. 4, 1922; especially Part 3, pp. 244–269; Part 4, pp. 17, 18; Part 5, p. 48; Part 8, pp. 64–68.

which then play a part of great importance as food for the fishes and for the guano-producing birds. More striking still are the immense schools of small fishes, the "anchobetas" (*Engraulis ringens* Jenyns), which are followed by numbers of bonitos and other fishes and by sea lions, while at the same time they are preyed upon by the flocks of cormorants, pelicans, gannets, and other abundant sea birds. It is these birds, however, that offer the most impressive sight. The long files of pelicans, the low-moving black clouds of cormorants, or the rainstorms of plunging gannets probably cannot be equaled in any other part of the world. These birds feed chiefly, almost exclusively, upon the anchobetas. The anchobeta, then, is not only . . . the food of the larger fishes, but, as the food of the birds, it is the source from which is derived each year probably a score of thousands of tons of high-grade bird guano. . . . No more forcible testimony to its abundance could be offered than the estimate, made roughly, but with not wide inaccuracy, that a single flock of cormorants observed at the Chincha Islands would consume each year a weight of these fish equal to one-fourth of the entire catch of the fisheries of the United States.[34]

The Distribution of Life as Affected by the Humboldt Current

Next to the extraordinary abundance of marine organisms in low southern latitudes, the predominant zoölogical characteristic of the Peruvian littoral is to be found in the unequaled northward distribution of antarctic or subantarctic types.

Examples to illustrate this fact could be drawn from many subdivisions of the animal kingdom, but the writer will confine his choice chiefly to the higher vertebrates with which, as a systematist, he is familiar. In the category of Peruvian species which are of distinctly austral or subpolar affinities are the following:

1. The southern kelp gull (*Larus dominicanus*), a subantarctic sea bird of circumpolar range, which breeds in numbers in Tierra del Fuego and upon ice-covered, heavily glaciated islands such as South Georgia and Kerguelen, also extends its breeding range along the tropical western coast of South America practically as far as the Humboldt Current is in contact with the land. Its northernmost breeding station, on Lobos de Tierra (6° 25′ S.), is, moreover, *one of its centers of maximum abundance*. On the Atlantic side of the continent the kelp gull apparently nests only south of the Rio de la Plata.

2. The white-breasted cormorant, or *guanay* (*Phalacrocorax bougainvillei*), the first in importance of the Peruvian guano birds, is a member of a well-defined, antarctic branch of the cormorant family. Its close kin are cormorants of the Strait of Magellan, New Zealand, various subantarctic islands, and the shores of the Antarctic Continent, while its relationship with other cormorants of South America or with those of the northern hemisphere is relatively remote. The range of the *guanay* extends along the west coast from central Chile to within six degrees of the equator.

3. Diving petrels (Pelecanoididae), representatives of a typically subantarctic family of marine birds, breed along the western coast from Cape Horn to the northern Peruvian islands (6° 25′ S.). In no other part of the world

[34] Coker, The Fisheries and the Guano Industry of Peru, p. 338.

are diving petrels known to breed north of about latitude 37° S. (viz. at Tristan da Cunha).

4. Penguins (genus *Spheniscus*) occur northward along the west coast to latitude 6° S., and an endemic species (*S. mendiculus*) resides on the Galapagos Islands, which are crossed by the equator.

5. The southern sea lion (*Otaria byronia*) is permanently resident along the west coast from Cape Horn to northern Peru, and a representative of the same genus occurs at the Galapagos.

FIG. 4

FIG. 5

FIG. 4—Breeding ranges of penguins and of sea turtles, the former determined by low, the latter by high ocean temperatures.

FIG. 5—Ranges of fur seals: the northern genus, *Callorhinus;* the southern genus, *Arctocephalus.* It is noteworthy that no fur seals occur in the warm waters littoral between northern Peru and Lower California.

6. The rare southern fur seal (*Arctocephalus australis*), recently noted by the writer at Independencia Bay, formerly ranged from Cape Horn to northern Peru and the Galapagos, throughout the path of the Humboldt Current. This genus, moreover, has succeeded in "jumping" the northern hydrographic barrier, for a related species (*Arctocephalus townsendi*) is resident off the Lower California coast and may still exist at Guadalupe and San Benito Islands (beyond 28° N.). The latter range, it should be observed, is north of the zone of tropical sea water, in which, of course, no fur seal is to be found.

7. In a similar manner, the southern sea elephant (*Mirounga leonina*) formerly occurred northward along the Chilean and Peruvian coasts to a point now indeterminable. An example has recently been reported from Ilo, Peru. This strange genus of seals reappears, like the fur seal, in the analogous littoral region of the California Current, where the northern form (*M.*

angustirostris) formerly ranged from Cape Lázaro, Lower California (24° 40′ N.) to Point Reyes, north of San Francisco.

In correctly attributing the range of these various animals and of their food supply to the influence of the Humboldt Current, it is easy at the same time to fall into a common error. Thus Boubier,[35] referring to the striking case of the distribution of penguins, states that cold currents not only maintain a low surface temperature and also probably assist in reducing atmospheric temperature (the isotherm of 20° C. roughly limits the distribution of penguins) but, what is more important, they transport an enormous mass of antarctic plankton upon which the birds feed. The organisms constituting this plankton live only in the cold waters, so that when the currents become warmed by traversing tropical seas before returning south (as along eastern coasts of the southern continents), they lose their antarctic plankton. Penguins are accordingly absent from these coasts.

The misconception here is not with regard to the main thesis of penguin distribution but in the idea that low surface temperatures and subantarctic plankton content are due to the transportation of surface water from high latitudes. It has been shown above that the temperature is accounted for by upwelling, which is very marked and very uniform, along great stretches of the western continental coasts. The conception of great "oceanic rivers," bearing northward the cold water and the living cargo of subantarctic seas, is altogether imaginary. The currents are at best extremely lethargic as compared with rivers of the land. The organisms that inhabit them do not originate in the far south, unless it be in an evolutionary sense, but are born, live, and die in the middle or low latitudes where they are found. It is not, in short, that the cold currents carry individual organisms across the temperate zones and into the tropics but rather that the vertical circulation produces life conditions, in narrow littoral belts, which resemble those of antarctic and subantarctic seas. The difference, in actual transporting power, between the deep, cold currents and such rapid surface currents as the Gulf Stream should be emphasized again.

As the Humboldt Current is a narrow stream, it need hardly be added that the composite range of the endemic marine fauna of the Peruvian coast is likewise a narrow ribbon of ocean, hugging the shore and projecting toward the equator from the far south. The facts were first suggested by Ortmann[36] in his studies on the distribution of marine decapods, but the larger implications have been steadfastly ignored by most zoögeographers. If we sail off shore across the current, we encounter a change in fauna which is closely correlated with change in surface temperatures; after a few miles the rich plankton, the sea lions, the penguins, cormorants, kelp gulls, and subantarctic petrels—an aggregate of thousands of species—all disappear. A new oceanic region with a distinctive fauna, rich in species, perhaps, but

[35] M. Boubier: La distribution géographique des manchots (Sphéniscidés) et son interprétation géophysique, *Rev. Française d'Ornithologie*, Vol. 11, 1919, pp. 131–136.

[36] A. E. Ortmann: Grundzüge der marinen Tiergeographie, Jena, 1896.

poor in the relative number of individuals per unit of space, spreads away across the vast expanse of the tropical South Sea.

The hydrographic and biological status of the tropical ocean to the northward of the Humboldt Current is even less well known than that of the Peruvian littoral. Although lying almost entirely north of the equator, this region is in barometric and thermal features the real equatorial belt of the eastern Pacific. The warmest surface temperatures are found north of latitude 5° N., the maximum isotherm moving up toward the Gulf of California during the summer. With the scanty data available, it is impossible to determine the full extent to which this zone acts as a biotic barrier. We have seen, however, that two genera of seals have succeeded in passing it. Recent studies upon the Peruvian littoral fishes,[37] moreover, show that the assemblage has its closest zoölogical affinities with the fishes of the Californian littoral and that both faunae have a pronounced Mediterranean facies.

A type of discontinuous distribution approaching "bipolarity" is produced in certain instances by the oceanic system of the west coast of America. An example is offered by *Emerita analoga*, a small decapod crustacean of the family Hippidae inhabiting a narrow strip of sandy beach within the wash of the waves. The distribution of the species is from Oregon to San Bartolomé Bay, Lower California, and from northern Peru to Chile. The intermediate zone, between Lower California and Ecuador, is occupied, as might be expected, by a tropical species (*Emerita emerita*) which occurs also along warm shores of the Atlantic side.

The antarctic giant kelp (*Macrocystis pyrifera*), the largest of seaweeds, which ranges elsewhere along the western coast of America from Cape Horn to Alaska, has not been reported from a hiatus between Lower California and northern Peru, i. e. the northern and southern points, respectively, at which the effect of cold currents ceases to be considerable. Conversely, this warm belt circumscribes the eastern Pacific breeding range of sea turtles, none of which, so far as the writer has been able to learn, deposits its eggs on beaches south of the Gulf of Guayaquil (3° S.), or north of southern Lower California. On the Atlantic coast the breeding grounds of these chelonians extend from Virginia to southern Brazil or beyond. The sea snakes (Hydrophidae) are likewise confined in their distribution along the western coast of America between 4° S. and 20° N., while the coastal range of crocodilians is entirely between the equator and the Tropic of Cancer. Finally, the distribution of reef corals along the Pacific coast is limited to the region between 4° N. and 21° N., whereas on the Atlantic side of the continents of America the range is bounded by the parallels of 22° S. and 34° N.[38]

Such are the conditions which illustrate an oceanic phase of the far-reaching interrelations of nature and show how pelagic circulation is the beginning of a system which so fundamentally affects both the dispersal

[37] J. T. Nichols and R. C. Murphy: On a Collection of Marine Fishes from Peru, *Bull. Amer. Museum of Nat. Hist.*, Vol. 22, 1922, pp. 501–516.

[38] The northernmost coral reef in the world lies off Beaufort, N. C.

and the limitation of marine life. It is not the writer's purpose to discuss here the moot subject of the effect of the Humboldt Current upon the distribution of terrestrial organisms along the Pacific coast of South America. Ashore, on the seaward slope of the Andes, we encounter complex climatic factors wherein the relative weight which should be given to oceanographic influences and to circumstances of purely continental meteorology, in the interpretation of such terrestrial distribution, is still open to question. Whatever a study of the facts may yield, it is significant that a very large number of land animals parallel the marine life of the Humboldt Current, inasmuch as they extend their ranges northward toward the equator in the narrow strip of coastal desert which faces from the mountains toward the Pacific.[39]

[39] Cf. F. M. Chapman: The Distribution of the Swallows of the Genus *Pygochelidon*, *Amer. Museum Novitates* No. 30, 1922 (especially pp. 11–15, with distributional maps).

THE FRENCH IRON INDUSTRY AFTER THE WAR*

By Jacques Levainville

In 1914 before the World War the iron industry of France presented the example of a perfectly stabilized activity. In the several parts of the territory where the industry was installed its particular aspects were in harmony with geographical conditions. The establishments of central France situated on the coal fields of the Loire, Saône-et-Loire, Allier, and Nièvre had given up the manufacture of cheap goods in favor of articles of superior quality and higher price—war material, high grade steel for automobiles, and tools. The furnaces of the north were for the most part concentrated round the coal basins of Nord and Pas-de-Calais. In earlier days they had engaged in the production of rails, girders, and ironmongery, but they were turning in increasing degree to the elaboration of more finished products. On the other hand the industry in the east situated on the greatest iron ore deposit of Europe, the Lorraine minette, had specialized almost entirely in the fabrication of primary products—rails, bars, wire rod, sheet iron. The eastern region produced 49 per cent of the steel fabricated in the whole of France. The central, northern, and eastern sections together manufactured 89 per cent of finished products. Outside of these centers the most important iron works were situated in the ports—Dunkirk, Calais, Boulogne, Caen, St. Nazaire, Bayonne—where Spanish and African ores were smelted with English coal. Finally, at many other places force of tradition, skill of the workers, certain advantages of geographical situation had maintained minor manufactories in spite of competition. These plants and those of the seaboard were devoted to special productions and thus were rivals of the central establishments.

Similarly the commercial situation showed a harmonious development. The total French production of 5,200,000 tons of pig iron and 4,686,000 tons of steel was consumed almost entirely by the home market. Our exportations comprised chiefly rails, bars, and sheet metal; our importations comprised machines and tools. We offered an important market for foreign metallurgy. From 1910 to 1913 German importations into France in this branch of industry had increased tenfold, English importations fourfold, and American fivefold. On the other hand our exportation of automobiles had attained great figures. In absolute value our commercial balance sheet showed a relatively small deficit. If the situation then was one of prosperity the future promised still better. Blast furnaces under construction in the northern section and in Normandy were planned to increase the annual production of cast iron by 1,000,000 tons in five years.

* A summary account from the last chapter of the author's book, "L'industrie du fer en France," Collection Armand Colin, Paris, 1922.

War was declared at a moment when the progress of French metallurgy was in full swing and when, on the other hand, a critical situation was threatened in Germany. In that country the question of iron supply, the progressive invasion in foreign markets by American products, and overproduction by the newly erected plants were causing alarm among the Westphalian ironmasters. Invasion of France offered a means of relieving this disturbing situation: new needs would be created by systematic destruction, French competition would be annihilated, and the famous deposits of French Lorraine (Briey and Longwy) unknown in 1870 would be acquired. The iron question determined the plan of attack. Hostilities began only when the Briey basin was invaded. Then the neutrality of Belgium was violated with the object, successfully realized, of seizing the coal fields of Nord and Pas-de-Calais. France found herself deprived of 90 per cent of her ore production, 68 per cent of pig iron, and 78 per cent of steel. Herr Schrodter was certainly speaking with a clear knowledge of the situation when he declared before the Verein Deutscher Eisenhütte in January, 1915, that the French metallurgical industry was seriously crippled, perhaps even partially destroyed.

It is well known how French energy solved the problem of repairing this damage without waiting for the end of the war.

The treaty of peace placed France in a position of incontestable mastery over the ore market, though without giving her coal resources equal to her needs. Consequently, our iron industry finds itself in an entirely new situation and for the time being has lost its equilibrium. Table I summarizes the chief elements in the problem.

TABLE I—SITUATION OF THE IRON INDUSTRY OF FRANCE

	PRODUCTION IN 1913 (*Unit, 1,000 Metric Tons*)			
	FRANCE	LORRAINE ANNEXÉE (MOSELLE)	SARRE	TOTAL
Raw Materials				
Coal (not including lignite)	40,129	3,795	13,218	57,142
Coke	4,027	91	1,900	6,018
Iron ore	21,919*	21,135		43,054
Unfinished Products				
Pig iron	5,207	3,870	1,371	10,448†
Steel	4,686	2,286	2,079	9,051‡
Finished Products				
Iron	406			406
Steel	3,186	2,027	1,652	6,865

* Not including 1,926,000 tons of Algerian and Tunisian ore.
† To this should be added 400,000 tons from the blast furnaces erected in Caen and Rouen during the war.
‡ To this should be added 600,000 tons produced by steel plants erected during the war.

The Raw Materials

Coal

In 1913 the production of coal in France amounted to 40,000,000 tons, consumption to 62,000,000 tons. Either as coal or coke the metallurgical industry absorbed 12,545,000 tons, or about 20 per cent of the total. Since the war the situation has become still more unfavorable from this point of view. Invasion deprived us of 50 per cent of our production, while 26 per

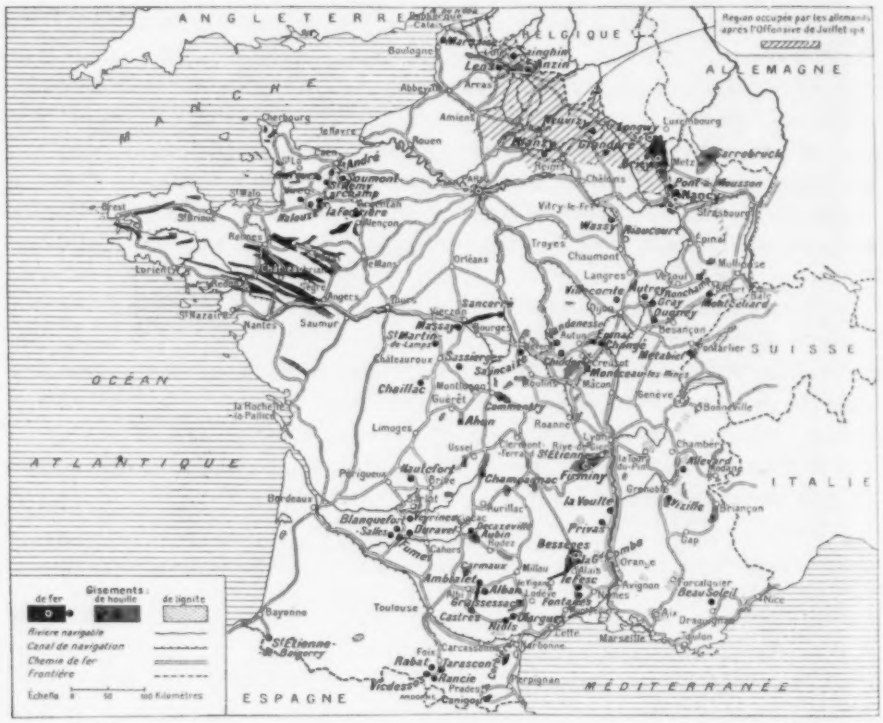

FIG. 1—Coal fields and iron ore deposits of France with chief lines of transportation. After J. Levainville: L'industrie du fer en France, Collection Armand Colin, Paris, 1922.

cent more was within cannon range of the enemy. Restoration at the close of the war by no means meant complete recovery; production in 1920 was scarcely more than 29,000,000 tons. In compensation for the destruction the coal mines of the Sarre basin were ceded to France; but the Sarre coal is not well suited for coking purposes. Before the war the metallurgy of Meurthe-et-Moselle (in which *département* lie the Briey and Longwy deposits) consumed 3,500,000 tons of coke a year, of which 1,200,000 tons came from Pas-de-Calais, the rest from Westphalia, none from the adjacent territory of the Sarre. In Lorraine Annexée, now Moselle,[1] of the 4,900,000 tons of coke used

[1] The restored provinces of Alsace Lorraine have become the *départements* of Bas-Rhin (Lower Alsace), Haut-Rhin (Upper Alsace), and Moselle.

three-quarters was from Westphalia; the remainder from various sources of which the Sarre was only one.

The mines of the Sarre do not solve the coal problem. On the contrary, it has been aggravated by the addition of the metallurgical industry of Moselle. The prewar deficit of 20,000,000 tons of coal and 4,000,000 tons of coke—reckoning a return of our coal fields to their normal production—will be replaced by a deficit of 16,000,000 tons of ordinary coal and 10,000,000 of coking coal. To assure the indispensable supply of coke for French metallurgy our technicians demanded from the Peace Conference a share in the Westphalian coal. This was not obtained.

In 1913 our importation of coal was valued at 536,000,000 francs, which went to enrich our neighbors and against which our exportation of ore was an insufficient counterbalance. The war has not changed this situation. In 1920 we paid over 400 francs a ton for coking coal, while it was sold in England at 84 francs and in Germany at 72 francs. It is especially the plants of Moselle that suffer from the deficit. The ores of Moselle are inferior in yield to those of Meurthe-et-Moselle. The output of the blast furnaces is inferior in that degree, and the consumption of coal is proportionally high. At the present time certain plants of Moselle use 1500 kilos of coke to the ton of pig iron, whereas in 1913 in Meurthe-et-Moselle 1000 kilos was considered the average consumption. Before the war these differences were of little importance. Unlike the textile industry of Alsace, which had remained in the hands of French families, the metallurgical industry of Lorraine Annexée, the establishments of Wendel being excepted, was entirely under the control of German concerns. Most often they were connected with the great metallurgical plants of Westphalian owners of Ruhr coal fields whence fuel was sent to Moselle. Coke could then be obtained at a better price here than in Meurthe-et-Moselle. These advantages disappeared with the signing of the peace treaty. The price of coal was the same on either side of the old boundary; and in the last analysis the pig iron of Moselle, which consumes the greater quantity of coal, is the more costly to produce. As before the war the question of fuel will dominate the future of our metallurgical industry.

Iron Ore

As a consequence of the war France far outranks all the European powers in her iron ore resources. In fact from the viewpoint of practical exploitation she is only surpassed in this respect by the United States. Her reserves amount to seven milliard tons without counting the considerable colonial deposits. On the basis of present exploitation and on the assumption that deposits will not be worked to a greater depth than 500 meters and that no new discoveries will be made it will take 136 years to exhaust these reserves. Impressed by these figures some of our economists have asked if it would not be well to leave to a distant date the exploitation of certain of our deposits—the ores of Brittany and Normandy, Algeria and Tunisia for example. With-

out commenting on the expediency of this measure it will suffice to recall the past of our mining industry.

The discovery of Henry Bessemer called for ores of a high degree of purity, in particular for ores free of phosphorus content. France was poor in ores of this character and consequently lost her world place as an iron producer. During the years from 1860 to 1870 a great number of furnaces shut down, notably in Brittany and Normandy; others continued only by importing foreign ore. Such was the state of our industry when, in 1880, Thomas and Gilchrist discovered the basic process for reduction of ores with a high phosphorus content. Forthwith the French ores assumed such importance that ironmasters of foreign countries hastened to acquire concessions in our fields.

Now no one can tell whether in consequence of some such scientific discovery, or some new line of transportation, deposits today of little value because too impure or too far from industrial centers will become exploitable in the future. What happened in the case of the phosphoric ores may happen in the case of the abundant siliceous ores or the arsenical ores long neglected but already beginning to enter into industrial use in the United States. "It is quite evident," writes M. Cayeux, of the Collège de France, "that often, if not always, there is an optimum period for the exploitation of bulky commodities and their market, of which iron ore is an example. To reserve them for a better but doubtful future, in any event long distant, is to leave the substance for the shadow, to let pass the moment ripe for exploitation." The French ores are passing through this optimum period, for our neighbors are short of this raw material.

In Spain the celebrated deposits of Bilbao which for so long supplied the European steel mills appear to be on the point of exhaustion. In 1912 the reserves amounted to some 60,000,000 tons. Other deposits yield a low percentage of iron, as in the provinces of Oviedo and Valencia, or possess a very high phosphorus content, as in the province of Léon. It would be rash to count on a reserve of more than a milliard tons for the entire peninsula.

Although Italy equipped a number of electrical furnaces during the war, her own ore production is limited to the deposits of Elba, and she is forced to import. She will be one of our customers in the future.

Belgium, on the contrary, in spite of her very modest area occupies a position in the front rank of the world's iron industry. She produces per head of population almost as much as Germany (278 kilos against 294 kilos), more than England (226), and more than double France (120). This enormous production is due in part to her abundant coal resources but especially to the excellence of her labor, able and hardworking in spite of low wages. Her ore deposits, a continuation of those of Lorraine, cover 354 hectares. She also imported before the war 6,000,000 tons of ore, four-fifths of which came from Meurthe-et-Moselle, the rest from Luxemburg and Lorraine Annexée.

"In England," wrote M. Tribot-Laspière in 1917, "the dominant charac-

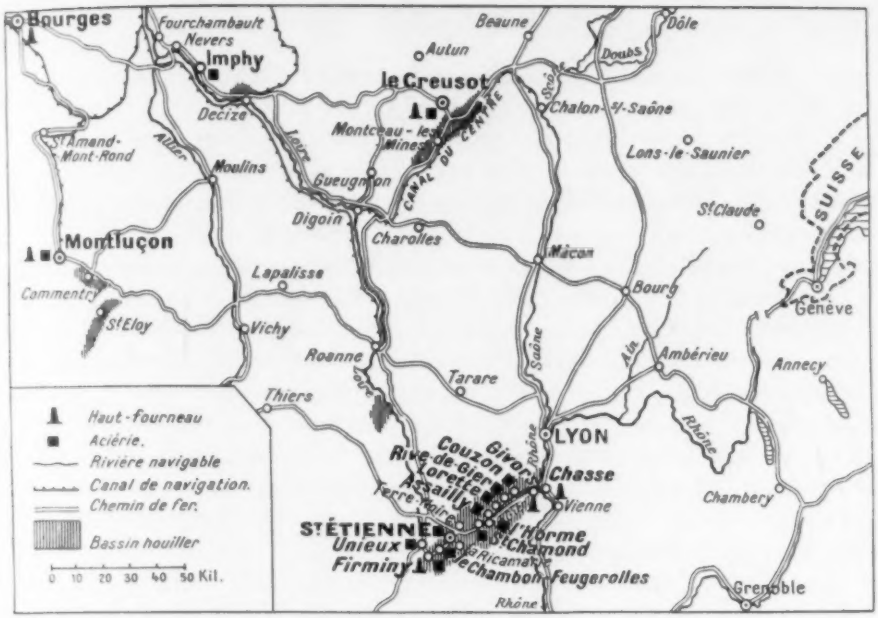

FIG. 2

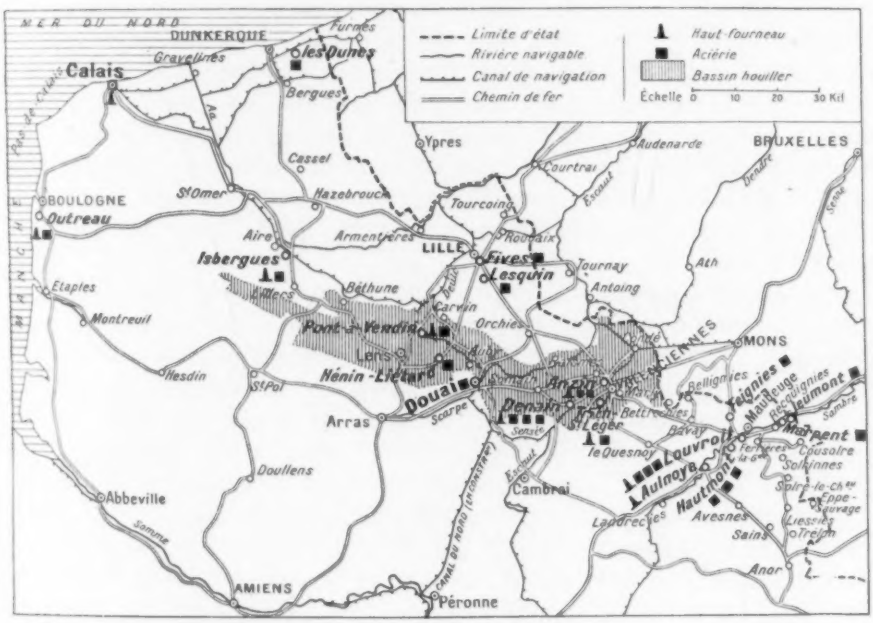

FIG. 3

FIG. 2—The metallurgical region of central France. Coal fields, blast furnaces, and steel mills and transportation lines are shown. After J. Levainville: L'industrie du fer en France, Collection Armand Colin, Paris, 1922.

FIG. 3—The metallurgic al region of northern France. Coal fields, blast furnaces, and steel mills and transportation lines are shown. Af ter J. Levainville: L'industrie du fer en France, Collection Arman, Colin, Paris, 1922.

teristic of the iron and steel industry is the present check in its progress . . . for a long time it has been outdistanced by the United States. Germany, in its turn, has risen to second place in production of ore, cast iron, and steel and threatens to arrive at an equal position in coal production." This decline is due in part to low domestic consumption, the isolation and routine methods of the English metallurgists, but most especially to exhaustion of the ore deposits. The English reserves are estimated at 455,000,000 tons; on the basis of the consumption in 1913, 24,000,000 tons, they will be exhausted in 20 years. More than a third of the necessary ore is imported, 7,600,000 tons in 1919, chiefly from Spain and Africa. It is only a transportation problem that prevents import of the Lorraine minette, which differs very little from the Cleveland ores. Our waterways are not economically available for ore transportation to the North Sea or Channel ports. Our nearest and most certain markets have always been found in Germany.

In 1910, at the Geological Congress at Stockholm, the reserves of the German Empire were reported as 3,600,000,000 tons. But in the first years of the war the value of this estimate was singularly diminished. To demonstrate the national necessity for the annexation of Briey the German metallurgists did not hesitate to avow their poverty. On December 8, 1917, before the Verein der Deutschen Eisen und Stahl Industriellen, the president declared, "Granting that the extraction from our mines follows the normal course of progress and that no artificial reduction is imposed, we shall see the exhaustion of the Lorraine deposits in 49 years, the spathic deposits of Siegen in 42 years, the red hematite in 66 years, and in 32 years the hematite of Lahn and of Dill. In 90 years we shall have almost entirely exhausted our resources. Germany must therefore be assured of foreign supplies. Thereon depends the existence of the industry, of the state, and of the people."

In 1913 the Zollverein (Germany and Luxemburg) produced 19,300,000 tons of pig iron from 39,911,000 tons of native ore and 11,000,000 tons of foreign ore. Yet the native ore yielding 31 per cent of iron could only furnish 10,500,000 tons of the product. The remaining 9,000,000 tons, or 46 per cent of the total, was produced from imported ore; or 80 per cent if one classes in this category the 8,600,000 tons of metal obtained in the Sarre and Westphalia by the smelting of imported minettes from Moselle and Luxemburg.

As a result of the war the German reserves were diminished by over 50 per cent in the restoration to France of the 1,830,000 tons of minette in Moselle. Prospecting recently undertaken in the region of Amberg and the Swabian Jura has not revealed compensatory deposits. On the basis of the above the German resources will be exhausted in 25 years. Reduced to an annual production of 2,700,000 tons of pig iron from domestic ore (8,000,000 tons of ore yielding 33 per cent iron), Germany will be forced to import considerable quantities of ore if she wishes to satisfy the national market of 12,000,000 tons of pig iron in 1913.

Without counting possible trade with the Netherlands where blast fur-

naces have been installed, with Italy with its hydro-electric establishments, with the United States which seeks our ore as return freight for coal, and basing our estimate solely on our assured relations with German, English,

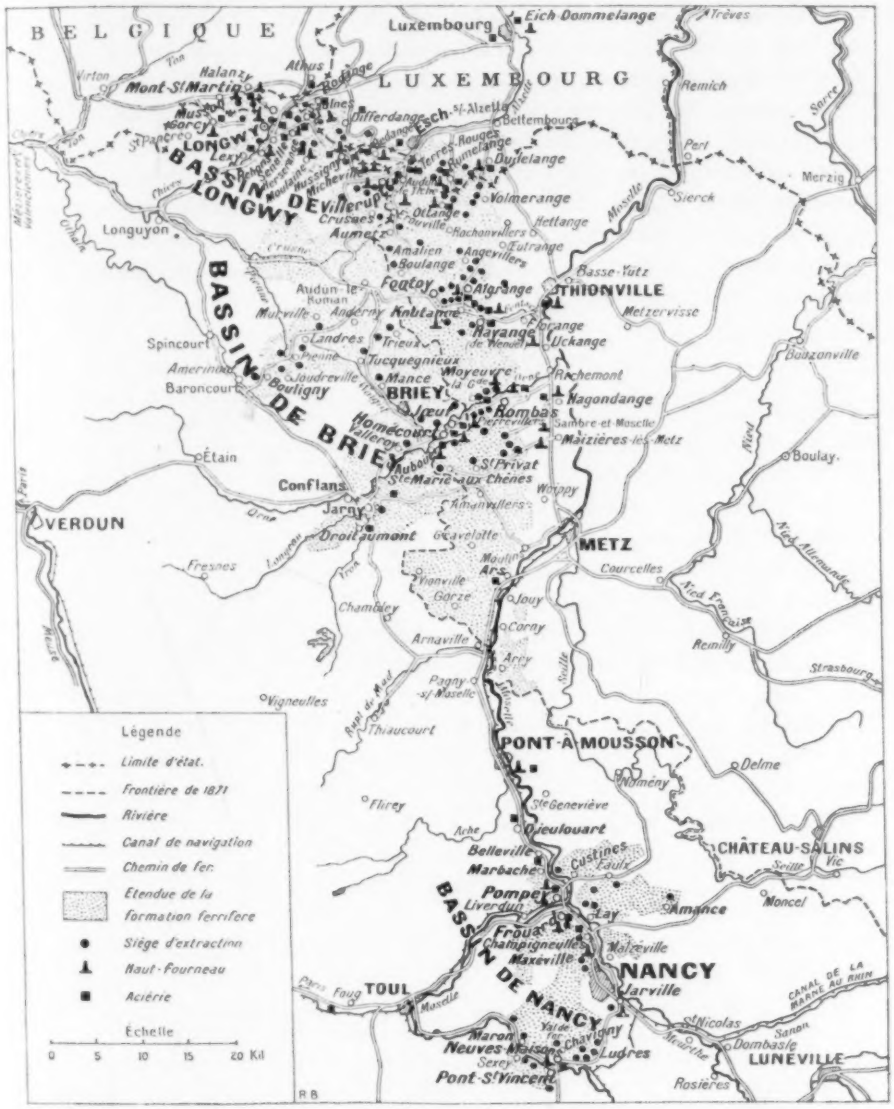

FIG. 4—The metallurgical region of eastern France. The extent of the iron-bearing formation, mines, blast furnaces, and steel mills and transportation lines are shown. After J. Levainville: L'industrie du fer en France, Collection Armand Colin, Paris, 1922.

and Belgian metallurgists it is not unreasonable to estimate our ore exports of the near future at 17,000,000 tons. In this respect the prospect is satisfactory; it is otherwise with the commerce in pig iron and steel, especially in the latter.

Metallurgical Production

When the plants of the northern and eastern districts are restored to normal conditions, France, including the production of the Sarre basin and Moselle, will be in a position to put on the market 11,000,000 tons of pig iron and 10,000,000 tons of steel a year. Should the Sarre territory be returned to Germany at the end of the 15-year period of French control, these figures will be reduced to 9,400,000 tons of iron and 8,000,000 tons of steel. We have seen that in 1913 domestic consumption was about equal to production. On the other hand, Moselle and the Sarre being quite unable to absorb their own production, French metallurgy will have to dispose of an important surplus. The situation is liable to deplorable results, which can only be avoided by judicious adjustments between the domestic and foreign markets.

The French Market

An increase in the home market is very probable. In France the consumption per head of population of pig iron (100 kilos) and of steel (90 kilos) is less than in any other nation engaged in metallurgical industry. In particular increase may be expected in the use of structural products and in machine construction. France, though rich in a variety of building materials, has limited herself largely to the use of stone and wood. Of structural steel we may expect an increased consumption of about 400,000 tons. But it is especially in machine construction that the largest gain may be looked for. Many industries are already expanding in this field. The automobile, for instance, is not used in France to the same extent as in England, while in neither country is it employed to anything like the same degree as in America. Statistics show one car for 400 people in France against 300 in England and 11 in the United States. The Committee of Arts and Manufactures estimates that machine construction will increase 79 per cent, corresponding to a demand for 1,000,000 tons of metal. A total of 1,400,000 tons for increased domestic consumption leaves 2,865,000 tons to be placed on foreign markets.

Before the war England exported 43 per cent of her production, Germany 33 per cent, Belgium 90 per cent, France only 10 per cent. It is in this respect that our industry is most susceptible of development.

The European Market

The victory of the allied armies led one to anticipate an easily found market in the neutral countries which had previously bought from Germany. As regards the iron industry, at least, our hopes have not been realized. Already favored by the price of coal, the German metallurgists are equally favored by the cost of labor. "In France," wrote M. Albert Despeaux in 1921, "the wage rate has more than quadrupled since 1914. In Germany,

expressed in the mark, it has been multiplied by 10 or 11; but, as the mark in relation to the franc has less than one-seventh of its prewar value, German wages have only increased by 100 to 150 per cent." In consequence, in Germany at this date iron was quoted at 1700 marks, or 260 francs (6.5 marks to the franc) the ton; in France at 400 francs.

Among the important consumers of German iron and steel products Great Britain is the one that offers the best market for our industry. At first glance it seems paradoxical that we should attempt to capture a market for the manufactured product in a country which buys from us large quantities of raw material. But it must be remarked that before the war Great Britain absorbed 1,200,000 tons of German iron goods, principally the output of Lorraine and the Sarre—semi-finished products, structural steel, and sheet iron. Furthermore, as regards the question of wages, the situation with us which compares unfavorably with Germany is, on the contrary, favorable as compared with that in Great Britain. After the armistice, in consequence of the coal crisis, of strikes, and of the rise in freight rates, the English steel manufactories were forced to import pig iron from Luxemburg and Normandy, whence, in spite of transportation costs, it could be obtained at a less price than at home. Here is an indication of the road we should pursue. By taking it we may liquidate a part of our debt for English coal.

The Extra-European Market

In the other markets struggle will be keen. Competitors more advantageously situated have arisen during the war. The metallurgical power of the United States has developed to a formidable degree. Already in 1913 the production of iron amounted to 31,000,000 tons and was almost entirely absorbed by the home market; in 1918 the production figure had risen to 39,000,000 tons and was disposed of in its entirety. Since then new blast furnaces have been built capable of an output of 45,000,000 tons, or 60 per cent of the total world production in 1913. This rapid growth has caused a changed orientation of commercial policy. As home consumption has been satisfied, exportation has grown; and metallurgical products today provide American shipping with cargoes of the first order of magnitude. In 1920 they amounted to 4,000,000 tons. During the war this export was mainly to the allied countries—France, Great Britain, and Italy. The signing of the armistice and the crisis in exchange put a restriction on sales to Europe. Export was then to the countries where exchange was more favorable, to markets most often gained at the expense of the English iron trade.

In 1920 Japan was furnished with 613,000 tons of iron by America, by England with only 116,000 tons. In their own colonies the English also have encountered serious competition. In this same year England sent Australia and New Zealand 187,000 tons, while America sent 52,000 tons; the figures are 221,000 tons and 74,000 tons respectively for India; 57,000 and 38,000 for South Africa.

At present the United States is the only metallurgical power in the New World but a development is beginning in other countries which will ultimately close them to foreign importations, notably in Chile and Brazil where capital from the United States is active. The time can be foreseen when the American markets will be closed to European industry.

Similarly the European war gave impetus to the creation of an iron industry in the modern sense in Asia and Australia. In Japan the project of erecting blast furnaces for an annual production of 1,500,000 tons of iron has not been realized in spite of financial assistance from the state. The present tendency of the Japanese industry appears to be towards establishment of manufactories on the continent in reach of the deposits which feed the steel mills of the archipelago; in Korea and in Manchuria, where Russian competition has been in evidence; in China, where the associations of Sino-Japanese capital compete for concessions with Sino-American capital. Equally in India the last few years have shown a remarkable development in iron and steel. Local consumption is no longer absolutely dependent on foreign supplies.

Australia, which long remained agricultural, appears now to have entered on the industrial period in its evolution. Its first blast furnace was erected in 1913; in 1920, 86,000 tons of iron were produced, an increase of 5000 tons on the production of the preceding year. The department of railroads has undertaken the construction of 20 locomotives. These new industrial developments cannot satisfy all home needs as yet, but they are significant of future possibilities.

Far from the markets of the Orient and Latin America, where we have been outdistanced for the present by competitors more advantageously circumstanced and where we shall be arrested in the near future by the growth of native industry, France can only hope to gain a place for her metallurgy in her African colonies and then only if prospective measures are taken to safeguard her interests. Successfully to maintain the industrial strife, to create new markets, to influence the government and public opinion the several branches of the iron industry must concentrate their forces; they must trend in the direction of integration.

Integration

The process of integration consists in taking the material in its raw state and controlling it through all its stages up to retail sale as finished product. In the iron industry, for example, integration unites under single control the iron and coal mines, the blast furnace, the steel works and rolling mills, the fabrication of machinery and tools, the metallurgical and machine shops, the naval construction yards, the transportation lines, and the mechanism of sale.

The process is not new. Before the war the ironmasters of the northern region, anxious over their stocks of ore, had acquired interests in the deposits

of Lorraine, Normandy, Brittany, and even Spain. Similarly the works in the east which lacked coke were assured of a good tonnage from the basins of Nord and Pas-de-Calais, in the Belgian Campine, in the fields of Aix-la-Chapelle, and even in Westphalia. But the most striking fact of the present moment is the amplitude taken by this movement and by its growth in a "vertical" sense.

Before the war the iron industry was specialized according to its location in the national territory. The present alliance between the metallurgists of the central, northern, and eastern sections has had for its objective joint reconstruction of destroyed works, exploitation of the whole mining and metallurgical field, and acquisition of new establishments in the Sarre and Moselle. For example the consortium formed by the Aciéries du Nord et de l'Est, the Société Métallurgique de Pont-à-Vendin, the plants of Espérance et Louvroil, the metallurgical works of Basse-Loire at Trignac has made itself master over the iron and steel works of Nord and of Lorraine, including the plant of Uckange and Neunkirchen. It controls in entirety or in part ore deposits whose reserves are estimated at 350,000,000 tons and whose annual extraction is 4,000,000 tons; coal fields in Pas-de-Calais, Vendée, Belgium, and England; 27 blast furnaces, 4 Thomas steel works, 3 Martin steel works, and 2 electric furnaces; coking ovens, slag grinders, cement works, manufactories of refractory products, foundries, iron works, and construction shops. The establishments of the Sarre and Lorraine furnish the Thomas steel and all the shapes and semi-finished products derived therefrom. The establishments of the Nord elaborate a part of the common products of exportation and of semi-finished products; the works of the Loire turn out finished products for naval construction shops and semi-finished products for exportation.

But integration leads the metallurgical industry to more distant conquests. If questions of freight rates or customs barriers block the free circulation of merchandise, the iron industry may attempt to set itself up in foreign territory.

After the war the Schneider works, whose principal seat is at Creusot, and the bank of the Union Parisienne formed the Union Européene, Industrielle et Financière for the development of economic relations, chiefly metallurgical, between France on the one hand and Czechoslovakia, Poland, and Hungary on the other. The consortium has acquired the control of the iron and steel works of Skoda at Pilsen, of the Société Anonyme des Établissements Réunis (distilleries and sugar refineries), the Société Berg und Huttenwerks, the forges and steel works of Huta-Bankowa in Poland, of the Banque Générale de Crédit Hongrois at Budapest. Finally the Établissements Schneider still share in the Compagnie Française du Levant, in the Framerican Industrial Development Corporation, the Société Espagnole de Construction Électro-Mécanique, the Société Anonyme Officine Metallurgiche Mecaniche de Tortone, the Union Industriale Italo-Francese—without counting interests in Russia, important before the war.

By transforming the economic methods of the iron industry, integration

has enormously enhanced its prestige. In France this power is divided up with rare exception among the numerous participating societies. On the contrary, on the other side of the Rhine it is concentrated in the hands of a few captains of industry who are thus enabled to impose their will on the state. It is significant that Hugo Stinnes was the representative of the Republic at Spa and Rathenau at Cannes. Both were at Genoa.

Conclusion

At the present stage the iron industry in France exhibits profound evolution in its economic function. In a comprehensive article[2] in the *Annales de Géographie*, M. Demangeon has shown that our metallurgists were long in throwing off the bonds of the past. On the eve of the Revolution, when metallurgy had become a large-scale industry among our neighbors, it remained a local activity in France. Metal was considered a rare commodity, almost a luxury; its use was confined to domestic utensils, agricultural implements, armaments, and hardware. In France the real iron age, or more exactly the steel age which has replaced it, dates only from the year 1880. In 1871, expounding the clauses of the Treaty of Frankfurt before the French parliament, Thiers declared that the metallurgical prosperity of a country was pure illusion and attempted to demonstrate that the lost territories were without value in this regard.

Handicapped by the lack of fuel our iron and steel industry had difficulty in entering into foreign competition; the domestic market also would probably have been lost but for the protective tariff. As it was, her importations like her exportations were insignificant as regards tonnage. Her industrial rôle was essentially national when war was declared.

The Treaty of Versailles has changed the factors in the problem. The return of Alsace and Lorraine to France raised her to an important world rank in the production of ore and metal, as has been shown statistically. To enlarge her horizon in the field of exportation and take her place in the world market is the next step.

National activity is too complex a thing to be characterized by one of its factors alone, but certainly agriculture is no longer entitled, as once it was, to represent the economic power of the country. "Pâturage et labourage," said Sully, "sont les deux mamelles de la France, les vrais mines et trésors du Pérou." True formerly, this dictum holds no longer. In France the use of iron is the essential element which has marked the great progress of the last fifty years.

[2] Albert Demangeon: La répartition de l'industrie du fer en France en 1789, *Ann. de Géogr.*, Vol. 30, 1921 pp. 401–415

THE HALLIGS, VANISHING ISLANDS OF THE NORTH SEA

By W. M. Davis

The estuaries of the Elbe and the Weser, opening in the angle where the shallow North Sea becomes shallower still between the Danish peninsula and the German-Dutch mainland, separate the low, 'longshore Frisian islands into two groups; a baker's dozen of larger islands from 5 to 30 kilometers in length and many little ones constitute the southern group and are known as West and East Frisian according as they belong to Holland or Germany; and about as many similar-sized islands constitute the other or North Frisian group, the members of which were associated with Denmark until the Schleswig-Holstein seizure in 1864 and have been since then mostly Prussian. A large part of the islands in both northern and southern groups, as well as a strip of mainland behind them, consists of salt-marsh land, little above mean sea level, and this suggests a two-chapter physiographic history: first, the construction of a fairly continuous belt of offshore sand reefs, built up from a shallow sea bottom by storm waves perhaps 2000 years ago and enclosing a very shallow lagoon where the marsh lands could be gradually filled in; and then the breaching and destruction of the sand reefs and the exposure of the marsh lands behind them to wave attack as at present. The occurrence of sand beaches backed with belts of dunes along the outer shore of some of the islands gives support to this two-chapter view. The change from the earlier period of sand-reef building and salt-marsh filling to the later period of their destruction is explained by some as the result of a slight subsidence of the region; and by others as the result of an increased range of tides with an accompanying swifter flow of tidal currents in consequence of the widening of the Strait of Dover by centuries of storm-wave action: the two processes may have co-operated.

Müller's Monograph on the Halligs

If one sets out from Blaavands hook, the sharp point on the west coast of Denmark between the continuous shore line of Jytland on the north and the broken shore line of Schleswig on the south, eight islands—Fanö, Mandö, Röm (the German-Danish boundary which ran north of this island before the Treaty of Versailles now runs south of it), Sylt, Föhr, Amrum, Pellworm, and Nordstrand—may be counted in a distance of 130 kilometers on the way to the marshy Eiderstedt foreland, 40 kilometers from the mouth of the Elbe. The islands of this stretch represent all that now remains of the outer part of the original marshland. The destruction is still going on, except where opposed by protective shore works. Around the last two of the above-

named good-sized islands, both of which are diked like the mainland border behind them, lie a number of smaller ones, greatly wasted patches of unenclosed marshland. They are known as the Halligs; and to the natural and human history of these and other small islands near by to the south, twenty-one in all, Engineer-Inspector Friedrich Müller of Schleswig devoted a great amount of study for many years of his life. After his death in 1914 his manuscript was revised and published in 1917 by Engineer Eger. It is a most painstaking monograph, replete with detailed information.[1] The first volume treats the Halligs as a group, describing their origin, their inhabitants, their storm floods, and their recent partial protection by shore works. The second volume treats each island separately. An atlas of 23 sheets contains many large-scale maps, in addition to the smaller ones of historic interest in the text. The first map is a section of the Prussian general map of central Europe, 1: 300,000, showing the entire Schleswig-Holstein region. The second gives all the Halligs with their house mounds and tidal channels on a scale of 1: 25,000. The third is reproduced from a German Admiralty chart, 1: 100,000, for the main Hallig district and exhibits the tidal flats and channels in much detail; the fourth is from the same source for the islands farther south. Among a number of reproductions of ancient maps, those of sheets 5, 6, and 7 date from 1597, 1640, and 1649 and thus show the beginning of the changes by which old Nordstrand has been reduced to its modern fragments. These changes are summarized on a chart, 1: 120,000, constructed in 1888, showing the shore lines of that date in red with the restored shore lines of 1643 in black. Other sheets are reproductions in color from minute Danish surveys in 1803 on a scale of 1: 5000. A few charts representing protective works are also given. The following account of the Halligs, although based on Müller's work, contains a number of items from other sources, chiefly from an excellent essay by Traeger,[2] in which geographical matters are appreciatively presented; and also from the Schleswig-Holstein Yearbook for 1922,[3] in which the well illustrated text is devoted to North Friesland, mainland as well as islands.

Physiographic History of the West Coast of Denmark

The level North Frisian marsh islands, separated by broad low-tide flats along the west coast of Schleswig, stand in strong contrast with the rolling hills divided by slender sea arms on the east side of the Danish peninsula. The latter constitute a segment of the latest terminal moraine formed by the lobe of the great Scandinavian ice sheet which crossed the Baltic sea, its

[1] Friedrich Müller: Das Wasserwesen an der Schleswig-Holsteinischen Nordseeküste. 2 vols and Atlas. Dietrich Reimer, Berlin, 1917. 11 x 7½ inches.

[2] Eugen Traeger: Die Halligen der Nordsee, *Forschungen zur Deutschen Landes- und Volkskunde*, Vol. 6, 1892, pp. 227–343. Stuttgart.

[3] E. Sauermann: Schleswig-Holsteinisches Jahrbuch: 1922. Hartung, Hamburg, 1921. This highly characteristic German annual opens with 12 pages for the months illuminated with colored Frisian designs; then come 122 pages of text by different authors, treating various aspects of the region and including a bibliography of 8 pages; at the end are 24 half-tone plates of North Frisian scenes reproduced from pictures by Frisian and German artists

western margin here lying about north and south while its southern margin is marked by the Pommeranian belt of morainic hills. From the hills on the east side of the peninsula the surface of Schleswig gradually declines westward as a plain of outwashed sand, interrupted here and there by low hills; fairly fertile at first and then at lower levels given over to barren heaths, until the sands change to clay and dip very slowly under the sea, to be covered by salt marsh as explained above. It is not only to the winds and waves but more particularly to the tides that the earlier construction of the marshland and the later destruction of its outer part are due. As long as a lagoon was enclosed from the shallow sea by the offshore sand reefs, flood and ebb currents probably maintained a number of narrow breaches or tidal inlets in the reefs; if the advancing flood currents were then made turbid with silt lifted from the outer sea bottom by storm waves, they brought the silt into the lagoon, where much of it settled among the seaweeds during high slack water; the ebb currents then ran out somewhat cleared. Since the protection of the sand reefs was lost, the action is reversed: the flood-tide currents, with however much silt they may be charged before reaching a marsh island, become still more heavily charged by attacking the island shore; a good part of the silt thus acquired is swept away by the more turbid ebb currents, and the marsh is slowly converted into low-tide flats. The marshland was probably from 40 to 60 kilometers wide when most fully developed; now its outer part over a breadth of 30 or 35 kilometers is largely converted into islands surrounded by sand and mud flats, which are subdivided by branching tidal channels, very broad for their length as compared to rivers. So slowly does the sea deepen that the line of 20-meter soundings lies 30 kilometers outside of the flats.

Action of the Tides upon the Halligs

Although the ordinary range of tide is only about three meters, its rise transforms a landscape into a seascape. At low tide the surviving islands, from one to five or ten kilometers across, are like green oases in a flat gray desert of sand and silt of similar breadth. At half tide the flats are covered, and the islands stand alone. At spring high tide only the larger dike-protected islands are kept dry; the undiked Halligs are all under water, except for the artificial mounds on which for centuries past the inhabitants have built their little groups of houses. When an exceptional on-shore storm wind first sweeps the flood current toward the shore and then retards the following ebb until another flood is raised still higher, the sea flows over the islands with double its ordinary rise; for the water being extremely shallow and therefore agitated by wave motion from surface to bottom, the heaping up of the on-shore drift cannot be checked by a compensating outflow beneath, such as is developed by on-shore winds where deeper water fronts the land. Hence at time of such storms even the mounds on the Halligs are drowned, and only the houses, or so many of them as are not broken down

and swept away, remain above water, like vessels at anchor riding out a storm.

The exposed western sides of the Halligs are sharply undercut in little bluffs, a meter or more in height and of angular outline; the turf binds the surface silts in a tough bed, which breaks off in slabs as it is undermined. On the eastern side of an island, where abrasion alternates with deposition, the marsh slopes gently into the flats. Each island is subdivided by many little tidal channels, some of which run from shore to shore; at times of storm the channels are widened by rushing currents. Thus exposed to assault from within as well as from without, and not only during storms but also by the continuous action of ordinary tides, the marshlands have been cut into islands, the larger islands of former centuries have been reduced to smaller islands, and some of the smallest have vanished.

House Mounds and Houses

It is believed that the building of house mounds on the marshland was practiced by an ancient people who were established there perhaps 2000 years ago, presumably when the outer sand reefs still held back the destructive storm floods; dike building is thought to have been introduced by a later people, presumably after the sand reefs had been breached and storm floods had become a serious danger. At present, and probably for ages past, the house-bearing mounds, built up of marsh mud dug from near-by pits, have a flat surface, five or six meters above ordinary high tide, and from 50 to 150 meters across at the top. They decline by a gentle slope that measures 20 or 30 meters on its descending breadth, this form being adopted in order to weaken the attack of the waves upon the mounds and houses at time of storm floods. Each mound usually bears from 4 to 10 or 15 houses, set somewhat irregularly; occasionally also a church and a schoolhouse, rarely a tree. The houses measure in plan 8 by 12 or 15 meters, more or less, and are all built on much the same one-story pattern. The brick walls are three or four meters high, with small windows; a steep-slanting roof, thatched or tiled, has its ridgepole seven or eight meters above the ground. Within, a hayloft occupies the roof space and provides the last refuge at time of storm floods; on the ground floor a passage, between rooms on either side with sanded floors and built-in beds, leads to a kitchen. A chimney, with an oven on the kitchen side and a stove on the other, rises above the roof. The dwelling rooms usually face to the south and west, as if to get more sunshine; winter stalls for cattle and pens for sheep and swine are on the north and east. Cattle dung gathered from the pasture fields and dried in the sun serves as the only fuel. Sometimes two or more houses are joined end to end; the number of chimneys then indicates the number of associated families. The house walls are built extra strong on the west side, for there the attack by storm waves is most violent; but the walls are enclosures rather than supports, for inside posts hold up the roof in case storm waves batter the

walls down. The western windows have heavy shutters to stand storm-flood pressure, and the outer doors have grooves in their frames to hold bulkheads, packed water-tight when flood tides rise over their sills. The lanes between the houses are paved; also the steps of broad tread and low rise by which the mounds are ascended. The houses now-a-days usually occupy a half or a third of a mound top, and kitchen gardens cover the rest; but it is thought that the present garden space was formerly occupied by houses when the marsh pastures were broader and the mound population therefore larger. One or more small areas in each mound are excavated in shallow pools, with sides of plank, to gather water for the live stock; snow carried into the pools in winter supplements the inflow of rain water from a small dike-enclosed area adjoining the base of the mound. Water is raised by buckets on sweeps or by pumps from the pools to the cattle troughs. A supply for household use is drained from house roofs into cisterns. As the rainfall is only about 700 millimeters a year, the cisterns sometimes run dry; and storm floods occasionally fill the pools with salt water. Fresh water has then to be brought from another island or from the mainland. Recently artesian wells bored to an aquifer 30 or 40 meters deep have yielded good water by pumping.

The marshland is covered with a rich turf of salt grass. The soil is frequently enriched on the undiked islands by silt from the highest tides; occasionally the turf is covered with an inch or two of silt from a single storm flood or buried to disadvantage under deposits of sand and shells swept up by heavy storms. Flowers are abundant in spring and summer; bees are kept in some villages. Ants are a plague; they in some way escape drowning even if several spring tides in succession cover the marsh; but they seem no more discouraged by such catastrophes than the human inhabitants are: the countless ant hills occupy space that cannot be well spared.

Seafaring and Farming

The people of the Halligs, by reason of their constant contact with sea and land for ten centuries at least, are seafarers as well as farmers. They are of Frisian origin and, like the inhabitants of the larger islands and of the mainland marshes, have always kept much to themselves. Some of them are driven elsewhere as the marshland is washed away, but no newcomers ever settle on the islands. The local language, although of old Germanic stock, is not intelligible either to Germans or to Danes; it is akin to English; the seafaring lingo in particular resembles that of English sailors. Today schoolmasters teach all the children standard German. As to seafaring, the men seldom have seaworthy boats of their own, and offshore fishing has never been actively carried on, perhaps because of the difficulty of leaving and making their mound ports through the tidal channels. It has long been the custom, though less generally now than one or two centuries ago, for those who intended to become sailors to gather at a town on one of the larger islands in the early spring and sail thence to Holland, especially to Amster-

dam, where they hire out for summer cruises; but they habitually return home for the winter, and as a result the house furnishings include many articles of Dutch manufacture. The returning sailors seek wives from among their own people; and a moderate excess of feeble-minded offspring appears to result from close intermarriage.

As to farming, the occupants of each mound hold the marshland in common for a radius of 500 or 1000 meters around. Part of the marsh is used for pasture, part for hay, divisions being made by ditches. The grass is not all cut at once, lest the entire crop might be swept away by a single spring tide; the cut grass requires from one to three weeks to dry and is then raked up, baled in sheets, and carried to the mounds by boat if tidal channels serve, but more commonly on the heads of the harvesters. Horses are unknown except on some of the larger islands at harvest time and except where certain flats are firm enough for inter-island traffic by wagon. Pasture rights are carefully defined for each family, the unit of area being that needed to support a cow; this unit is reckoned to suffice for two yearlings, four sheep, six calves, and eight lambs. As the sea encroaches upon a Hallig, the pasture rights are diminished all round; a family that had eight units of pasture may lose half a lamb's need per unit, or half a cow's need in all. In summer the cattle are left on the marshes, except that they are daily driven to the mounds to be milked and watered; and also except that during spring high tides they are driven up the mounds and kept in outside sheds. In winter the live stock remains within the houses; their stalls and pens in absence of sufficient straw for litter are floored with planks.

The Life of the People

It may be well imagined that life on a Hallig consists of a simple round of duties. The women are good housewives and keep the living rooms clean and neat in spite of their being under the same roof with the cow stable and sheep pen. The days of summer are busy; many of the men being then at sea, the home members of the family must gather the hay crop and tend the cattle. The days of winter are quiet; for then the marshes are deserted, and the sailormen at home again share not only in the labor of feeding the live stock in the stalls and pens but also in spinning and knitting. A very democratic spirit prevails, as if because the population has long been subdivided into small communities in which every one worked at similar tasks and no one had much more or much less property than any one else. It appears to be chiefly the sailor who, becoming a captain and a successful trader, lays up more wealth than his neighbors. The children are kept at home until they can be trusted to cross the ditch bridges safely. Then they go to a school of rigid discipline on a central mound; but schooling is not carried far. While in their own houses the children are held to strict obedience of parental commands. They have no games, no songs; indeed, among the elders singing is taken as a sign of tipsiness. Little wonder that the men of such a folk

are reserved and silent, given to brooding rather than to talking, except when their tongues are loosened with drink. Little wonder that all the inhabitants of the Halligs, fathers and mothers, old and young, are devoutly and primitively religious, all the more so by reason of the dangers to which they are exposed. Their preachers have long exercised much authority among them. Besides the preacher and the teacher, there is an officer charged with the disposition of jetsam found on the shore under traditional rulings, which have become so complicated as to discourage the report of findings. More important is the elected board of three or more members whose duty it is to divide, mark off, and record the strips and patches of pasture and hay land each spring; and, what with changes of rights by inheritance and purchase and with decrease of marsh area by sea encroachment, the labors of this board are arduous. A prevailing skill in numerical reckoning is plausibly ascribed to the need of understanding fractions in the assignment of pasture rights.

Among the great events of the year are the market days, spring and autumn, in the towns of Wyck on the neighboring island of Föhr, or of Husum on the mainland marsh border. Home products are then sold, and supplies are laid in for months ahead. Communication between the little islands is not easy, even in summer; many are the stories of danger and loss of life on the tidal flats, when the rising tide delays progress and fog hides all landmarks. In winter, inter-island traffic is made more difficult by drifting ice in the channels. Not the least of the dangers of isolated life on the Halligs arises from the difficulty of securing medical care when illness comes, for doctors are to be found only in the towns on the mainland or the largest islands, and much time is lost in fetching them. In recent years a telegraph cable has been laid to connect the chief islands, but the little ones are still isolated, unless the telephone has supplemented the telegraph.

Storm Floods

The main epochs in the history of the Halligs are marked by great storm floods; and so overwhelming have the floods been that in the course of centuries many hundred thousands of human lives and millions of cattle and sheep have been lost by drowning. Fortunately it rarely happens that tides and winds combine in such a way as to produce the greatest catastrophe: a spring-flood current running northeast toward the islands must be driven to exceptional height by a southwest gale, and then a shift of the gale to the northwest must oppose the ebb current which tends to run off in that direction and thus allow the second flood to rise still higher than the first.

The catastrophes of the Dark Ages are vaguely known. They appear to have led to the construction of protective dikes in the following centuries. The greatest storm flood of which a definite record is preserved is that of 1634, when, although Holland was little disturbed, the diked island of Nordstrand, then measuring roughly 20 by 30 kilometers, the ancestor of

most of the Halligs, was devastated. Its dikes were breached in 44 places, 1300 houses were destroyed, 6000 inhabitants and 50,000 animals were drowned; only 400 inhabitants survived. Of the present islands, one still called Nordstrand and another Pellworm, each about 10 kilometers across and both diked, together with a number of little undiked Halligs, are all that now remain of the ancestral island. A flood in 1825 was most severe on Hooge, a marsh-remnant Hallig outside of the original Nordstrand, at present about five kilometers across. The water there rose 14 feet above ordinary high tide; on four mounds the houses were all destroyed, and three inches of silt were spread over the marsh. This rapidly wasting island had 16 mounds with 153 families in 1758, but only 9 mounds with 41 families in 1894. Repeated losses of lives and property by overwhelming storms have been so disastrous that the abandonment of the islands has been proposed by non-residents; but the Hallig survivors hold their ground. On the whole it has been found wiser to preserve the islands by protective works around their shores, in part because the population furnishes many sailors to the navy and the merchant marine.

Pictures of Island Life

Those who wish to learn more of the Halligs than is told in Traeger's geographical description and Müller's monograph will find the homely ways of the Frisian islanders set forth in an overpious and rather too melancholy novel, "Die Hallig," by Johann Christoph Biernatzki (Leipzig, 1881), who as pastor of one of the islands nearly 100 years ago had intimate personal knowledge of them; his story closes with a vivid account of the storm flood of 1825. From an altogether different and quite unexpected source comes a most interesting account of a Hallig peasant family. The eminent and gentle-minded philosopher, Friedrich Paulsen, recalls in his autobiography, "Aus meinem Leben" (Diederichs, Jena, 1909), stories that he, as a boy in his home on the mainland marsh, heard about his forbears and their early life on the small Hallig, Oland, in particular that great event, the storm flood of February, 1825, when the fatal combination of wind and tide occurred.

Surely, no more striking example than that of the Frisian marshes, and of the Halligs in particular, can be found in which a remarkably uniform land of apparently unfavorable character has been persistently occupied by a simple folk under nearly constant conditions century after century, so that it has become to them the center, the home, with respect to which all the rest of the world is only a periphery.

THE EFFECT OF GLACIATION ON PROSPECTING FOR MINERAL DEPOSITS IN THE LAURENTIAN PLATEAU *

By T. L. TANTON

Geological Survey of Canada

The evidence of Pleistocene glaciation is one of the outstanding features in the Pre-Cambrian shield—a region noted for its mineral wealth—and an attempt is here made to present a concise, general statement indicating what the net result of glaciation has been as it affects prospecting in that region.

The method used is to consider various glacial phenomena in relation to the mineral occurrences of the region, to infer what the condition would be if there had been no glaciation, and to judge from field experience whether the effect to prospectors was beneficial or otherwise in the three physiographic divisions which are recognized within the Pre-Cambrian shield.

The ease with which mineral deposits are now found depends on the following conditions.

1. *Visibility of deposit.*—This condition involves (A) outcrop of deposit, (B) accessibility to an observer.

A. The factors which are to be weighed under this head are as follows:

The factor in glaciated area	*The factor in unglaciated area*	*Result to prospecting in the Pre-Cambrian shield*
(*a*) The deposition of ground moraine, original and reworked	Residual soil; transported deposits, viz., stream and lake deposits, hillside wash, beach deposits, marl deposits	Result considered by districts (map)
(*b*) Scouring of the rocks to an unweathered surface	No equivalent degree of visibility could be expected in unglaciated region	Result considered by districts (map)
(*c*) Disorganization of drainage system resulting in very numerous lakes which for this particular region greatly assists human accessibility	Present degree of inaccessibility of the plateau is due to lack of roads which would have been built had there been a suitable soil and climate to induce agricultural settlement. Since present climate is a controlling factor there is really no equivalent off-setting factor to be considered here	Nil in clay belt, elsewhere favorable

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2. *Clues to position of deposit which are not directly observable.*—The factors which are to be weighed under this head are:

The factor in glaciated area	*The factor in unglaciated area*	*Result to prospecting in glaciated area*
(*a*) Transported fragments from mineral deposit aligned in the drift in the direction of glacial advance	Transported fragments from mineral deposits follow irregular courses controlled by gravity and local drainage system	Compensate
(*b*) Heterogeneous drift	Productions of easily recognizable gossan over ferruginous deposits	Unfavorable
(*c*) Irregularities in thickness of drift not deducible by glacial geologists	Thickness of cover over magnetic deposits might be deduced with more certainty, thus allowing of more important results from magnetometric survey	Unfavorable
(*d*) Physiographic features alter in such a way as to render the recognition of significant rock structures difficult	Drainage features may conform to significant structural features, e.g. faults	Unfavorable
(*e*) Topographic irregularities intensified where depth of easily transported material was not uniform thus bringing into prominence shattered fault zones bounded by hard, dense rocks		Favorable

The Clay Belt

The "clay belt" is an area of considerable size which in the Pre-Cambrian shield borders the Paleozoic rocks in the James Bay district. There are a number of comparatively small, irregular areas which have similar characteristics, but only the larger areas are indicated on the map. In these areas the bed rock is presumed to be of the same character as in the typical shield; but outcrops constitute less than one per cent of the area, and there is a deep mantle of till (largely Paleozoic débris) and post-glacial lacustrine clay deposits. There are comparatively few lakes in the clay belt.

The extent to which the bed rock would have been concealed by fluviatile, lacustrine, and other loose deposits in the same area had it not been glaciated is a matter for speculation. A full discussion of the matter would involve so many purely theoretical considerations that the result would have little significance. It is manifest that in this area we find, developed in the highest degree, the obscuring of the bed rock by a heterogeneous mixture, largely of foreign débris, which gives no indication of the nature of the material be-

neath. It is a safe generalization that the net result of glaciation, in so far as the clay belt is concerned, has been unfavorable for prospecting.

Upper Pre-Cambrian Areas

In the areas underlain by Upper Pre-Cambrian rocks the gently inclined sediments and great sills of diabase have been faulted and dissected by erosion; the local relief is high, the soil cover is thin, and lakes are numerous. The scouring of the rocks, the removal of old talus accumulations, and the

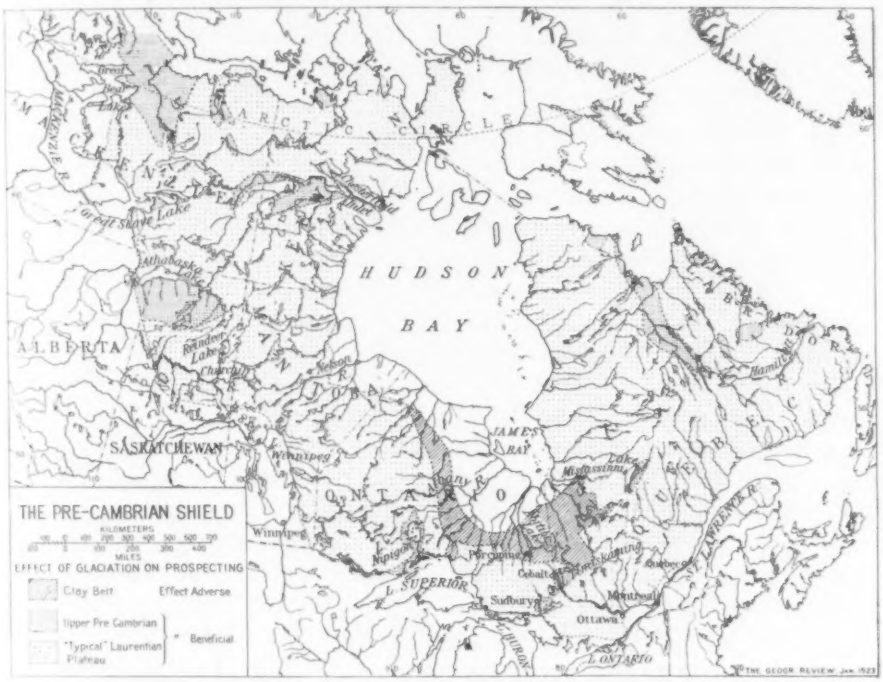

FIG. 1—Map to illustrate the effect of glaciation on prospecting for minerals in the Laurentian Plateau. Scale of map approximately 1:35,000,000.

cleaning out of loose materials in zones of structural weakness transcend in importance the glaciation effects which are undesirable from a prospector's standpoint. The minerals sought for are in veins which frequently occupy faults. The general effect of glaciation has been decidedly beneficial for prospecting.

Typical Laurentian Plateau

The typical Laurentian plateau is characterized by mammilated, rocky hills and ridges of low relief, an irregular but generally thin mantle of till, and a disorganized drainage system made up of abundant lakes and interrupted spillway rivers. A statement of the various effects of glaciation makes it clear that the prospector for all types of deposits has been favored in some

measure and obstructed to some extent; and, so far as the actually coming upon the deposit is concerned for one traversing the ground, there is an almost complete compensation from the glaciation-effect factors.

While traversing certain Keewatin areas remote from frequented routes of travel, the writer has stripped moss from veins which would warrant the expenditure of time for examination by a prospector. He has felt that the means which rendered the district as accessible as it is, i.e. the numerous lakes due to disorganized drainage resulting from glaciation, is to be regarded as a material benefit to the prospector.

Some light on the question may be gained by considering the conditions under which successful prospecting has been carried on in northern Ontario and speculating as to the probable difference had the district been unglaciated.

The Sudbury copper-nickel ores were found in outcrops. Rock outcrops are sufficiently numerous to permit of areal geological mapping. With the geological map and the information gained in early development work Dr. Coleman was able to state a theory of genesis and to deduce that a certain more or less oval zone would be the site in which ores might be expected to occur. An attempt to locate ore in a drift-covered part of the zone has met with success. Intensive prospecting through the drift is not now carried on because the ores so found are not commercially recoverable in competition with outcrop ores. Had the district been unglaciated, the factors relating to human travel remaining the same, it is probable that prospecting would have been easier on account of the existence of a pronounced gossan of limonite and the green secondary minerals of copper and nickel.

In the Cobalt district the first discovery was made by the chance encounter of silver by a workman engaged in constructing the Temiscaming and Northern Ontario Railway. Such a number of fortuitous circumstances led to this first discovery that the question of glaciation or non-glaciation is here insignificant. Following the first discovery there was a rush, and a sufficient number of rich veins were discovered to establish an important mining camp. The factors which were mainly responsible for success were—the bareness of the rock, the accessibility of the trackless forest by means of canoe routes, and the existence of a geological map which was sufficiently accurate along canoe routes to enable prospectors to concentrate their attention on these rocks which the theory of ore genesis indicated as most promising. Had the district been unglaciated, prospecting would have been very much more difficult since the narrow calcite veins would probably occur in depressions and be covered with slumped soils or transported products of rock weathering.

In the Porcupine district outcrops of gold-bearing quartz veins were discovered long before the famous discoveries which caused the rush in 1909. During and after the rush a great many gold-bearing quartz veins were found in outcrops. The greater part of the mineralized area is covered with the deposits which characterize the clay belt. The earliest reported discovery

and also the one which caused the rush were made in consequence of the veins lying in plain sight from a portage trail on a canoe route between Mattagami River and Nighthawk Lake.

Had the district been unglaciated, would the gold-bearing quartz veins have stood up as more prominent ridges? Would the loose surface deposits have masked more of the important veins or less? Is not the beneficial scouring effect of glaciation largely offset by the general smoothing of the country which makes possible a masking of a large area by a comparatively thin lacustrine deposit? There is ground for argument on all these questions. In the writer's opinion more gold-bearing quartz veins would have been exposed than is now the case, but the chances of discovery, away from any water route, would have been less.

ARGENTINE PHYSIOGRAPHICAL STUDIES: A REVIEW*

By Alan G. Ogilvie

Modern investigations of land forms in South America are very few, and it is a pleasure to be able to review the results of five which have appeared in the last two years. All of them deal with the sierras and cordilleras of Argentina; four are short papers, and one an important monograph. The paper by Sobral deals with parts of the area treated in the monograph by Penck and will be discussed after the latter. The regions studied, then, are four: the southeastern border of the Puna de Atacama with the Sierra and Bolsón de Fiambalá to the east of it, northern Neuquén near the Chilean boundary, the Sierra de Tucumán, and the Sierra Grande de Córdoba. All of the authors are geologists, and, while their physiographic researches necessarily and properly in most cases have been closely bound up with other geological work, their results might have been more generally useful—to geologists as well as to geographers—if they had included in their presentation more graphic accounts of the landscape.

Southern Edge of the Puna de Atacama and the Sierra and Bolsón de Fiambalá

Walther Penck in his geological study of the southern edge of the Puna de Atacama has furnished "a contribution to knowledge of the Andean mountain type and to the question of mountain formation"—to quote the subtitle of his work. This voluminous treatise of 420 pages with eight plates of photographs, one of geological sections, and a geological map, represents the results of two periods of close and industrious field work carried out in 1912 and 1914 on behalf of the Dirección de Minas of the Argentine government. There are few such thorough regional studies in the geological literature of South America, and certainly Penck is the first to investigate in such detail the structural and surface features of one of the important and characteristic tectonic basins of the eastern Andes. To have this intimate and admirable

* Walther Penck: Der Südrand der Puna de Atacama (NW-Argentinien). Ein Beitrag zur Kenntniss des Andinen Gebirgstypus und zu der Frage der Gebirgsbildung. vi and 420 pp.; map, diagrs., ills., bibliogr. *Abhandl. Math.-Phys. Klasse der Sächs. Akad. der Wiss.*, Vol. 37, No. 1. B. G. Teubner, Leipzig, 1920.

José M. Sobral: Some Physiographic Notes on the Sierra de Famatima. Map, ills. *Geografiska Annaler*, Vol. 3, 1921, pp. 311–326. Stockholm.

Pablo Groeber: Mutación del divortium aquarum del norte del Neuquen en el Plioceno superior. Map, diagrs. *Bol. Direcc. Gen. de Minas, Geol. e Hidrol., No. 1, Ser. F. (Informes Preliminares y Comunicaciones)* pp. 1–17. Buenos Aires, 1920.

Franz Kühn: Notas sobre la orografía de Tucumán. 2 panoramas. *Fenix*, Vol. 1, 1921, pp. 48–52. Buenos Aires.

Oscar Schmieder: Apuntes geomorfológicos de la Sierra Grande de Córdoba. Map, diagrs., ills. *Bol. Acad. Nacl. de Ciencias en Córdoba (República Argentina)*, Vol. 25, 1921, pp. 183–204.

portrait of a typical *bolsón* and its surrounding mountains is to go a long way toward understanding the physiognomy of a hundred others; and this is a necessary preliminary to the appreciation of Andean geography. The area studied was first surveyed topographically by the author; and the result, an excellent map on the scale 1: 200,000 with contours at 100-meter intervals, was published in 1918.[1]

The Puna de Atacama is the southern part of the Puna region which occupies the major portion of the Central Andes. We now have presented to us in an accurate and definitive manner the important transitional area in which these high broken plateaus of interior drainage meet the lower and more habitable region of the sierras and valleys drained by the La Plata system. The area studied lies mostly between 27° and 28° S. and between 67° and 69° W. Its western half and northern fringe are regarded by the author as belonging to the Puna. Its eastern half includes the Sierra de Fiambalá with the Cerro Fraile; and between these and the Sierra de Famatina, which is the Puna rim, lies the depression, or *bolsón*, of Fiambalá.

No attempt will be made here to review the volume as a whole, the place for such a review being a geological journal. But, before passing to a discussion of the aspects more directly affecting the geography of the region, it may be useful to say something of the content of the work. In the opening chapter various geographical questions are briefly dealt with—position, orography, climate, hydrography, landscapes, and settlements. Two long chapters (137 pp.) follow, in which the rocks, igneous and sedimentary, are described and their geological significance is treated; and these are followed by two other chapters (106 pp.) dealing with geological history and tectonics. It may be noted that the broad aspects of the building of the Andes receive thorough treatment in this section. The work is concluded with a discussion of the surface evolution of the Puna rim. The longer, meridional axis of the *bolsón* marks the division between mountains, on the one hand, which belong structurally to the pampean sierras and, like the Sierra de Córdoba referred to above, are composed mainly of ancient crystalline rocks and, on the other hand, the ranges of the Puna rim on the west, which belong to the pre-Cordilleras and include folded sedimentary rocks (Paleozoic) in their composition. Perched high on the greatly denuded surface of the Puna, which extends westward to the Western Cordillera and the Chilean boundary, there are several isolated groups of volcanoes. The parallel mountain ranges which form the southern fringe of the high plateau may be considered, broadly speaking, as finger-like remnants of the highland now separated by structural hollows—the *bolsóns* and *valles* of northwestern Argentina. While the more obvious surface features, the contrast of high, smooth Puna with its volcanoes with the rugged fretted eastern rim, are due in the main to a geological history including long periods of emergence and denudation followed by large tectonic disturbances, the land forms derive

[1] Walther Penck: Topographische Aufnahmen am Südrand der Puna de Atacama (NW. Argentinien). *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1918, pp. 193–212.

their character in detail from peculiarities and contrasts of the climate of the present and recent past, as well as—especially on and below the Puna rim—from variation in rock type.

Penck describes the existing climate in some detail and furnishes explanations of its features. The contrast is pronounced between the fringing hollows on the one hand and the high sierras and Puna on the other. The prevalence of a more or less permanent area of low pressure on the low Chaco to the east of the Andes occasions a very regular and strong daytime wind on the Puna; and this is cold and dry, the only precipitation in this region being the snow brought to the high volcanoes from the southwest, by occasional moving depressions. This westerly current does not become a down-valley *föhn* wind on the eastern slope of the mountains but appears to maintain its level, and so must enter the low pressure area gradually. When the Chaco "low" retreats, a biting north wind (*zonda*) supervenes on the Puna. In his discussion of the plateau winds the author's use of the term "anti-trades" seems to be misleading. From its association with references to altitude and latitude (pp. 31 and 254) it is not perfectly clear to the reviewer whether he is using the term correctly to denote the upper return currents of the trade wind zone or applying it incorrectly to the westerlies of lower latitudes.

The intense daily heating of the Bolsón de Fiambalá induces a regular south wind which springs up in the south and spreads northward throughout the forenoon. By early afternoon it ascends the northern rim of the Bolsón and becomes cooler, but as a rule it does not pass an altitude of 4000 meters. This wind carries much sand and builds it into large dunes, which are a constant menace to the farmers of the valley. These winds are not followed by north winds at night, and the author believes that this daily access of air to the Puna level finds compensation in the prevailing westerlies there. The most important wind from the economic as well as the physiographic standpoint is the easterly wind of summer; for with it comes the only rain of the Puna rim, mostly in the form of thunderstorms. But even in summer precipitation is the exception in the Bolsón; commonly cloud only is formed. In summer the high sierras become "islands" in an intensely dry region which are relatively moist on their eastern sides. Thus watersheds have been pushed westward; springs, streams, and alluvial fans are on the eastern side, and here also are the sparse settlements. The Sierra de Fiambalá is higher in the north (over 5000 meters) and consequently receives more rain there and is more thoroughly dissected.

The hydrographic results of such a combination of relief and climate may be briefly stated. The only perennial streams are, paradoxically, the antecedent rivers which come from the Puna (Río de la Troja, Río Chascuil), receiving their entire water not from the plateau itself but from the melting snows of the isolated volcanoes. The summer streams, which are most intermittent, being occasionally in high flood, at other times generally dry, are mostly on the eastern slopes of the sierras. The detritus of the highlands, then, so far as it is water-borne, reaches the Bolsón from the west, and the

great alluvial fans have pushed right across the depression. Thus the settlements, which are entirely agricultural—Tinogasta, Puesto, Fiambalá, and Medanito—are near the eastern edge of the Bolsón. The first three of these, named from south to north, receive water from the Puna rivers, while Medanito is entirely dependent on the Bolsón water tables emerging at successive levels in the meridional channel known as the Río Abaucan. These agricultural towns subsist by the irrigation of the fertile sandy loess which covers the eastern part of the Bolsón, and they produce by irrigation heavy crops of wheat, maize, alfalfa, oats, grapes, figs, oranges, pomegranates, olives, and other fruits. Palms do not grow, although they flourish in the Bolsón de Andalgalá of similar latitude and altitude. The remainder of the sparse population lives in scattered farms on the alluvial fans to the west mostly below 2500 meters. In winter the Puna and sierras are unpopulated, but in summer flocks are pastured at high altitudes. The four towns show signs of decay owing to the decreased importance of two ancient trade routes which converge here, coming respectively from the Copiapó region of Chile and from Bolivia by way of Antofagasta de la Sierra.

Penck has made a very systematic study of the processes of denudation in this arid climate; and he brings out his conclusions in systematic form, showing the divergences from the laws which apply in moist climates. While these conclusions for the most part are not new, it is exceedingly valuable to have this detailed investigation from South America. Morphologically the region falls into well defined zones. On the Puna mechanical disintegration is by far the most potent agent. Every surface of bare rock is rapidly broken up by the sharp temperature changes, and the whole region is being rapidly leveled and is tending towards an undulating surface covered by a thick mantle of rock fragments of all shapes and sizes. Transportation downwards, of course, takes place under the influence of gravity. It is shown that movement is initiated in the following manner. At a given moment the angle of slope is such as to maintain stationary the mantle of a given mixture of fragments, large and small. But the fragments are continually being reduced in size, and adjustment of slope to suit changing mixtures destroys equilibrium. This constant adjustment maintains a downward motion. Thus the number of large blocks is found to diminish downhill, and, since the rate of motion increases with the proportion of small particles and so becomes more and more rapid, these latter are to be regarded in some sense as a medium of flow comparable to water. In such a manner large areas may be leveled without reference to any base level outside the area.

On the Puna rim the rock mantle makes its way to marginal valleys and is held even to widen and deepen these by abrasion. In the valleys the base level of such erosion and transportation is the alluvial fan, which of course is itself the product of the summer floods (*crecientes*). Such features and processes characterize the Puna and its rim above about 3800 meters. Down to this level accumulation has predominated for a long period. The cold, arid climate of the Pleistocene in this region favored accumulation quite as well

as does the warmer aridity of the present, and it prevailed to a level from 600 to 800 meters lower than does the present similar condition. Thus the author explains a zone below 3800 meters marked by deeply dissected Pleistocene deposits—the second of his marginal terraces of the Bolsón, the highest of which is regarded as of Pliocene age. These terraces are held to mark stages in the differential movements which have produced the Bolsón. Reduced to simplest terms, then, the Bolsón rim consists of smooth upper slopes with a thick mantle of fine rock fragments, deeply dissected lower slopes marked by successive terraces in valleys and on interfluves, and great alluvial fans rising to 400 meters and varying in slope and extent according to the nature of the rock from which their materials are derived. Study of the longitudinal profile of the Río Abaucan, which is the main artery of the Bolsón, reveals some interesting features. In such virtually enclosed and arid depressions a general base level of erosion plays no part, as it would were there a regular drainage to the sea. Instead we find a series of water tables in the body of the alluvial fans, and each of these forms the base level of erosion for successive stretches of the Río Abaucan. This operates in such manner that the river alternately flows in a shallow channel and in canyons, the canyons corresponding to the reaches where the bed is on one or other of the water tables.

This monograph will be valuable to every student of the geography of arid regions and of the critical and fluctuating zone in which slight increases and decreases of moisture may have far-reaching results. It would seem that such a monograph might with advantage have contained a brief summary of conclusions, furnished with references to pages. In the absence of an index or at least a summary with references it is difficult to use a book of such length as the work of reference which it ought to become.

Sierra de Famatina

The paper of José M. Sobral loses much of its value from the fact that most of its elements are treated more systematically by Penck, who covered the northern portion of the Sierra de Famatina in his investigation, while that of Sobral deals with the southern part. He starts by contesting the statement, contained in a paper by Franz Kühn[2] (not yet received by the reviewer), that the higher parts of the Sierra de Famatina are remnants of an elevated peneplane. With this the author does not agree, believing that all traces of the old surface have been removed by denudation. He points out that, while he has observed in the highest ridges of the Sierra numerous amphitheaters which are undoubtedly the remnants of glacial cirques (also observed farther north by Penck), nevertheless all the lesser evidences of glaciation have been removed. Now he thinks there is little doubt that this range, reaching to over 6000 meters in altitude, was heavily glaciated in the Ice Age, and he believes that if the glacial surface has been destroyed to such

[2] Franz Kühn: Observaciones morfológicas en la región central de la Sierra de Famatina, *Anal. Museo Nacl. de Hist. Nat. de Buenos Aires*, Vol. 30, 1920.

a great extent it is unreasonable to look for remnants of a preglacial peneplane. Penck, however, demonstrates that the range was not heavily glaciated. There are cirques with terminal moraines down to 5200 meters, but no evidence of valley glaciers. Moreover, he describes extensive Pliocene surfaces as existing today. Like Penck, the author has been greatly impressed with the thick and widely spread mantle, or "slide rock," of angular fragments disintegrated by atmospheric agencies and moving under the influence of gravity. He describes carefully the conglomerates composed of angular fragments cemented with limonite at altitudes varying between 2500 and 4500 meters. This the author, in agreement with Penck, takes as evidence that the same processes of denudation which he notes as characteristic today have long been going on. The conglomerate is held to be of postglacial or perhaps of interglacial age, and the author notes especially its existence in the valley of the Río Amarillo at 2500 meters, pointing out that at the time of its formation there can have been no stream at that altitude capable of clearing its valley and, further, that the climate which presumably favored the cementation by limonite—short periods of heavy rain followed by dry sunny periods—is not now characteristic. But it is nearly matched today in the much higher valley of La Mejicana at about 4600 meters.

In a note the author refers to the occurrence of *nieve penitente*, the jagged surface of snow fields produced so characteristically in the strong sunshine of the Southern Andes and about which there is a considerable literature to which this footnote is a preliminary contribution. He throws out a suggestion which may have more than merely local application. He believes that the initial cause of the feature is the differential movement of the rock slides underlying the snow. This causes a crevassing of the surface so that in the troughs the slide rock may be seen. Further snow falls both on ridges and troughs; but subsequent wind deposits more dust in the troughs than on the ridges, and the heat absorbed by the dust melts the snow in the troughs more rapidly and so accentuates the ridges and pinnacles.

Northern Neuquén

During the earlier part of the Pliocene period the most northerly part of Neuquén was drained to the Pacific, and much of the relief of that time was subsequently buried by thick volcanic deposits. The proof of this fact forms the main subject of the paper by Dr. Pablo Groeber, the result of investigations made in the spring of 1919.

Four diagrammatic cross sections are drawn to illustrate stages in the morphologic evolution of the region. In phase one, a peneplane of early Tertiary age cut upon tilted porphyrites and Jurassic and Cretaceous sediments is seen to be covered by a thick andesite sheet lying nearly horizontally. In the second phase, this is thrown into a broad anticline of which the axis coincides with the Cordillera del Viento immediately east of the present upper Neuquén River. At the end of the third phase partial planation has

again been attained, the andesites having been denuded from the higher parts of the anticline; and, lastly, after further uplift the planed surface is shown as deeply dissected. This last diagram represents the region in the earlier part of the Pliocene and prior to the burial of the surface under the basaltic sheets which greatly modified its aspect. But this burial itself antedated the last great uplift of this part of the Andes, which took place from later Pliocene to Pleistocene times. The author has studied in some detail the relief (early Pliocene) which existed prior to the spread of the basalt, and he comes to the conclusion that a leading feature in it was a deep longitudinal valley occupying the axis of the anticline above referred to and

FIG. 1—Diagrammatic sketch of part of Neuquén immediately north of the Cordillera del Viento, viewed from the south, slightly simplified from the diagram by Pablo Groeber. The left (western) half is occupied by the basin of the Río Varvar-Co with Lake Varvar-Co-Campos draining to the Río Neuquén. The valleys of the right background drain to the Río Barrancas. The Cerro Domuyo is in the right foreground.

drained northwards from near the present Cerro Domuyo by an ancestor of the existing Río Maule. From near the same peak another river, an ancestor of the Río Ñuble, ran westward across the present head valleys of the Neuquén. Thus the region was drained to the Pacific Ocean. All this was changed by the infilling of the valleys by volcanic materials, and the present aspect of the landscape depends mainly upon this and upon the subsequent dissection of the basalt owing to great uplift of the whole system. The effect of rejuvenation in the rivers is much less marked in the basin of the Río Varvar-Co than in that of the Río Barrancas on the eastern edge of the area, since the former flows into the Río Neuquén and is much more distant from the foot of the Cordillera.

The paper contains no summary or sketch to show clearly which parts of the present relief are to be referred to the various phases; but from the "imaginary panoramic view from 10,000 meters" and the map on which "prebasaltic" contours and drainage have been drawn it would appear that only very small parts of the present surface can be referred to the earlier phases. The panorama would have been more useful physiographically had it been converted into a block to show the geological sections on two of its edges.

The main features of the existing landscape (see Fig. 1) appear to be:

1. A line of serrated ridges forming the summits of the Cordillera del Domuyo extending from north to south and separating the drainage basins of the Barrancas on the east and the Varvar-Co on the west. These ridges seem to be fretted by the Pleistocene glaciers.
2. The extensive undulating surfaces of basaltic accumulations trenched in places by rather shallow glacial valleys.
3. Numerous steep-sided valleys deeply dissecting this surface, their upper edges often marked by precipices corresponding to basalt flows, and the valley bottoms here and there occupied by lakes such as the Lago Varvar-Co-Campos.

Orography of Tucumán

Sierra de Tucumán is the name given to the eastern slope of the Sierra del Aconquija and its northern extensions. The hydrographic system is typical; wide longitudinal valleys, lying approximately north and south (tectonic basins), and narrow transverse *quebradas*, due to progressive erosion. Thus the mountains are divided into isolated blocks.

The brief paper of Dr. Kühn, which is virtually an explanation of two panoramas, is not as helpful as it might have been to a reader who desires to receive a general impression of the land forms and their origin. Panorama I, looking west from a tower in the city of Tucumán includes a section of the mountains some 110 kilometers in length. The horizon consists of a line of summits varying in altitude from 4200 to 4500 meters and taken to represent portions of an elevated peneplane of pre-Tertiary age. In this panorama the accordance of level in the summits forming the horizon is well brought out. These summits are described as remnants of an elevated peneplane broken—presumably by subsidence—in the longitudinal valleys, which are referred to as tectonic basins, and dissected by erosion in the transverse valleys.

Panorama II, in which the view is eastward, shows a smaller stretch of country mostly hidden by nearer hills in Panorama I. The hills seen in this are assigned to a "pre-Tertiary peneplane" whose relationship to the higher surface mentioned above is not disclosed; but a higher peak is described as a "monadnock," and it would seem that this may represent an isolated portion of the higher erosion surface.

Sierra Grande de Córdoba

The plateaus and ridges which are thus named lie to the west of Córdoba, extending from north to south for some 400 kilometers with a breadth of 100 kilometers at the widest part. Of all the pampean sierras this is the one most widely separated from the Andes. Oscar Schmieder has made a preliminary physiographical study of the section lying to the southwest of Córdoba—about 3000 square miles in area.

The crystalline and Paleozoic rocks of these plateaus have been regarded as an isolated block of the Brazilian shield. In the part discussed granites appear to occupy the chief place. The author's conclusions regarding the genesis of the plateaus may be briefly stated. The Sierra here consists mainly of broken remnants of a pre-Tertiary peneplane with their longer axes north and south and both tilted to the east. Between the blocks is the *bolsón*, or structural basin, of Nono, which is drained to the southwestward by a river incised in the southern extremity of the more westerly block. The northern edge of this block abuts on the recent volcanic mountains of Salsacate. The more easterly block is flanked on the east by a cuesta known as Sierra Chica, continuous save for the gaps through which the higher Sierra is drained eastwards. The chief complication occurs in the more easterly

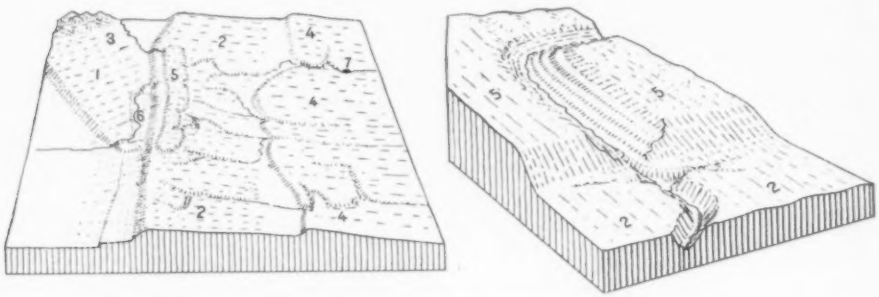

FIG. 2—Block diagrams drawn from data in the paper by Oscar Schmieder.

a (left). The region viewed from the south: 1, western tilted block(Pampa de Pocho); 2, eastern tilted block; 3, volcanic mountains of Salsacate; 4, Sierra Chica; 5, the horst (Pampa de Achala); 6, the *bolsón* of Nono; 7, Córdoba.

b (right). Portion of the blocks 2 and 5 viewed from the southeast, illustrating the relationship of the valley terraces to the fault scarp.

block. A forty-mile section of the upper western part of this tilted plateau has been thrust up to a still greater elevation, thus forming a horst. The relationships of these features can be seen in the diagram (Fig. 2) generalized from the author's map and section.

The peneplane surface appears to be best preserved on the highest block, the Pampa de Achala. Here there are many shallow valleys of small gradient and numerous low residual hills often consisting of resistant parts of the granite. Rejuvenation of the valleys due to the last positive movement which has resulted in the deep dissection of the eastern block has so far only notched the edge of the horst. The most detailed part of the author's work has evidently been devoted to this plateau, and he has revealed the existence of interesting terraces of erosion in its valley. These are taken to mark the successive stages of uplift of the block. They are three in number, and all of them are "hanging" terraces in the sense that they end "in the air" on the eastern scarp of the block (see the diagram, Fig. 2, which has been drawn with the help of the sections and photographs contained in the paper). The highest terrace lies generally parallel to the tilted surface of the horst, while

the two lower—parallel to each other—make a considerable angle with the highest. The author, taking the terraces to mark successive uplifts of the horst, concludes that this section of the peneplane with its old valleys was first tilted eastwards and then, after being dissected down to the highest terrace, was subjected to two vertical thrusts by which the eastern scarp was formed and later increased in height. The two lower terraces mark the stage of dissection reached prior to these positive movements. The present bottom of such valleys corresponds to the upper surface (the peneplane) of the eastern block.

All of the works reviewed make some reference to one or more surfaces of erosion, some of them actually existing, others revealed as buried or deformed peneplanes. This fact encourages the hope that such observations by other geologists in other parts of the Andes will quickly accumulate and that the date is not far distant at which evidence already collected—such as that from the Central Andes—can be correlated with the new results. We can then look forward to a much simplified, comprehensive picture of Andean relief, to be used as a basis for understanding irregularities which fundamentally are of minor importance.

GEOGRAPHICAL ELEMENTS IN THE TURKISH SITUATION: A NOTE ON THE POLITICAL MAP

The Treaty of Sèvres, signed but never ratified, has finally become a dead letter with the consequence that the revised political maps of the past two years must undergo another revision. The treaties between the Allied and Associated Powers and the Central Powers have been ratified, and their territorial clauses have gone into effect with minor modifications.[1] The different fate of the Treaty of Sèvres is not surprising. It was apparent early in the war that the Turkish settlement would probably be the most difficult of all. The policy of the Ottoman Empire with reference to deportations, massacres, and conscription had brought about ethnic distributions calculated to make the setting up of government by minorities an almost impossible task even if the matters of territorial adjustment and boundary definition had not presented problems of the first magnitude. Treaty making was further complicated by the territorial provisions of the so-called Secret Treaties (London, Sykes-Picot, St. Jean de Maurienne, Sazanov-Paléologue) signed during the war by which nearly the whole of Turkish territory was divided into spheres of influence designed to be under the control of Great Britain, France, and Italy.

For an understanding of the developments that have led to the present situation it is helpful to turn to the geographical elements of the problem. On the one hand, we have the distribution of the chief material assets of the Turkish Empire—population, railways, ports, products; on the other, the less ponderable but no less vital questions of religion and prestige.

Religion and Prestige

The Turk has grown too well accustomed to modern life to miss the significance of trade in making religion a business. And there is no doubt at all that Mohammedanism is good business for the Turk. Most of the 270,000,000 Mohammedans in the world are so situated that they can make capital out of their religious kinship if they so desire. They form a sort of fraternity inhabiting an area of unrest wider and deeper than Europe itself and separating Europe from the tropical and subtropical lands of the Old World. In their arid or semiarid terrain they have an excellent natural defense. Their geographical situation places in their hands vast possibilities for making trouble. For the past one hundred years the Turk has given ample proof that he well knows the principle that not only power but also the balance of power matters, whether in business or politics. England

[1] See the *Geogr. Rev.*: The New Boundaries of Germany According to the Peace Treaty, Vol. 7, 1919, pp. 281–290; The New Boundaries of Austria, Vol. 8, 1919, pp. 345–349; The New Boundaries of Bulgaria, Vol. 9, 1920, pp. 299–305; The New Boundaries of Hungary, Vol. 10, 1920, pp. 408–412.

could be relied on to solve the Mohammedan question of northern India if there were not millions of other Mohammedans beyond the Indian frontier. France is perpetually involved in the Mohammedan question, holding Morocco at one end of the Mediterranean and Syria at the other, a distance of more than 2000 miles.[2] Italy was giving a new orientation to her Mohammedan policy when she signed a treaty of peace with the head of the Senussi confraternity whose stronghold is desert Libya[3] and when she retired from Albania to please the Mohammedans there and thus keep the goodwill of the Mohammedan populations about the eastern end of the Mediterranean.

The trade motive is likewise revealed in the Near Eastern policies of the three powers—France, Italy, and Great Britain. The war debts of these powers and the need for trade revival under exceptionally favorable circumstances have increased the competition for Levantine trade and economic privileges in the tributary lands. Given such a situation, the opportunity of the Turk, historically an exploiter himself long before the western powers learned the art, lies plain before him.

Distribution of Population According to Numbers and Religion

Something of the strength and weakness of the Turk in his former Empire is seen in the map (Fig. 1), showing the distribution of Mohammedans.[4] The dotted line marks the northern limit of the Arab peoples. It is in close accord with the modification of the Treaty of Sèvres line in the Angora agreement. The solid Turkish block of western Anatolia, the basis of a national Turkey, has its centers in Angora and Konia, typically interior towns. The chief ports and coast regions of densest population have a considerable non-Turk element, chiefly Greek.

The extent to which the Turkish Empire would have been reduced by the Treaty of Sèvres, had it been ratified and enforced, may be appreciated from the map (Fig. 2) no less than from the population figures of the eight principal towns left in Turkey.

Constantinople	1,000,000
Brusa	110,000
Kaisaria	54,000
Konia	45,000
Sivas (Sebasteia)	65,000
Bitlis	40,000
Trebizond	55,000
Diarbekr	38,000

[2] Compare the article by E. F. Gautier, "Native Life in Northern Africa," and the note, "The Census of 1921 in French North Africa," in this number of the *Review*.

[3] Compare the note, "The Political Geography of Italian North Africa," in the *Geogr. Rev.*, Vol. 12, 1922, pp. 134–137.

[4] Both this map and that of population density are based on pre-war statistics, and in many places the actual conditions today depart widely from those shown. Nevertheless, such maps are of real value in that they show where population established itself under stable conditions and where it is likely to resume its usual activities, for the immutable facts of relief and climate and geographical position will recall into being much the same centers of production; and racial activities, while subjected to far more varied and complex controls, tend to revert to the old channels.

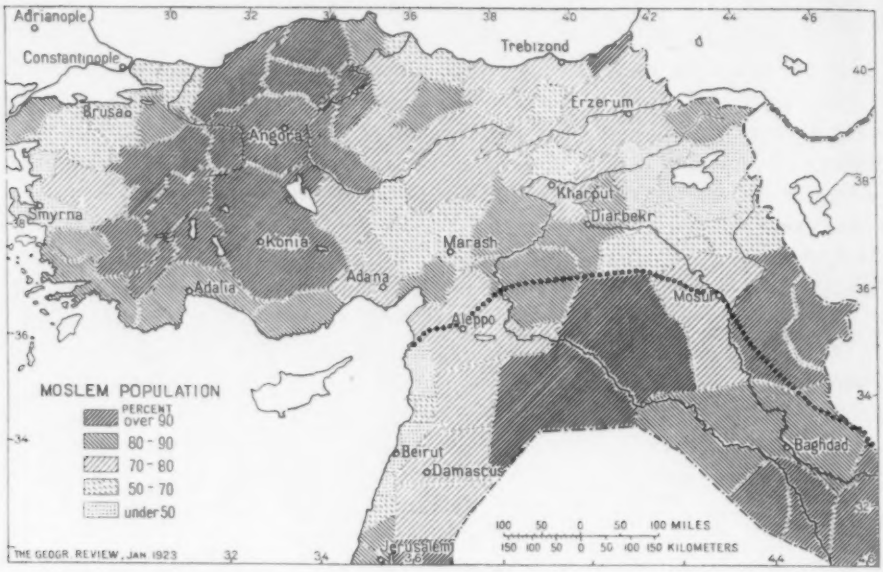

FIG. 1

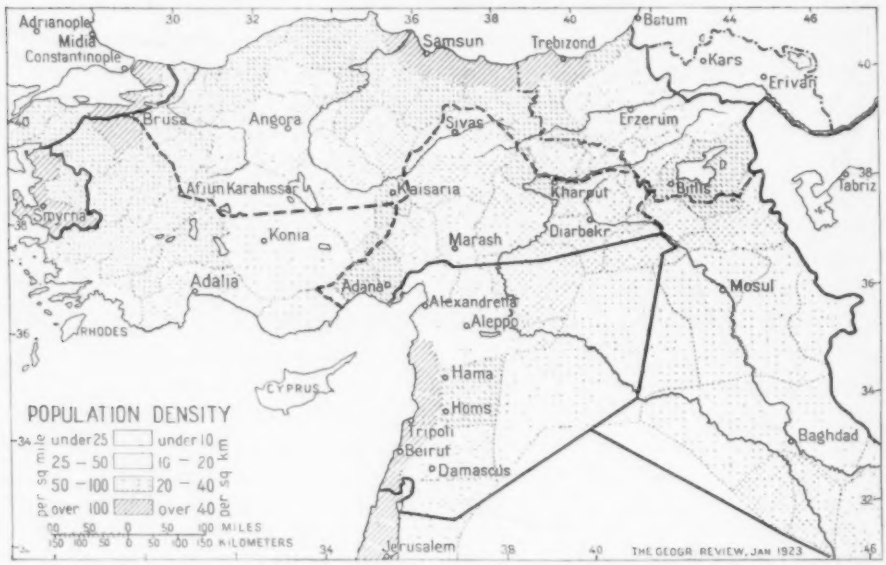

FIG. 2

FIG. 1—Percentage of Moslem population in Asiatic Turkey by sanjaks before the war (see footnote 4). The line of heavy dots represents approximately the northern and eastern boundary of the Arab lands.

FIG. 2—Density of population in Asiatic Turkey by sanjaks before the war. In conjunction is shown the proposed division of Turkey by the Treaty of Sèvres (solid lines) and the Tripartite Agreement (broken lines): Zone of the Straits, Greek zone in the Smyrna district, Italian zone in southwestern Anatolia, French mandatory area in Syria and zone of influence in southeastern Anatolia, British mandatory area in Mesopotamia and Palestine. The dot-and-dash line represents President Wilson's boundary on the Turkish side for the proposed state of Armenia.

Economic Aspects

The disposition of the main bodies of population about the rim of the Anatolian peninsula takes on a further significance if examined in conjunction with the map showing railroads and port statistics. The dry interior of the peninsula being ill served with railroads, it follows that sea communication between the different parts of Turkish territory (as cut down by the Treaty of Sèvres) is vitally affected by the control of the Bosporus. Upon this historic strait focuses the national life of Turkey. It is by ship and

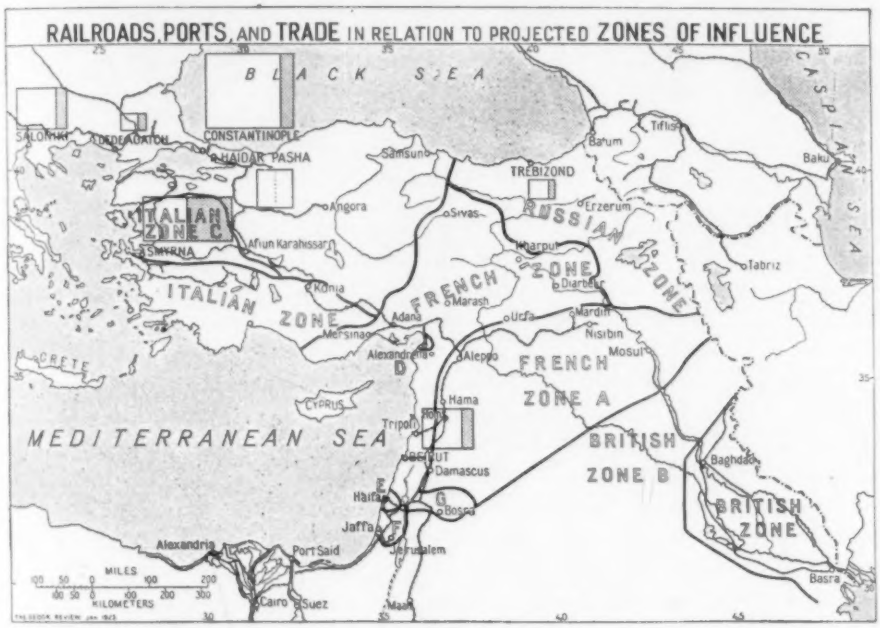

FIG. 3—Adjacent to the principal ports are rectangles representing proportional value of trade—the open portion, imports; the shaded portions, exports. Statistics are for 1910–1911, that is before the Balkan wars in which Turkey lost the majority of her European holdings. The railway net is for 1922. Zones of influence are drawn as laid down in the Secret Treaties. A, B, C are supplementary zones; D, E, F, G are special areas mentioned in the various agreements. Compare with Figure 2.

caravan that the principal trade of Turkey is transported; the era of railroad building has only begun. The representation of port statistics shows graphically that the interest of Constantinople and of the Anatolian peoples in the Aegean Sea is of the first order, a fact not to be overlooked when appraising the historic position or trade or ambitions of the Greeks.

Smyrna is the chief exporting center, and Constantinople leads in imports. The statistics for the seven ports are as in Table I.

The territorial losses of the Balkan wars deprived Turkey of Saloniki and Dedeagatch, two of the seven ports of chief importance. The prospective loss of Smyrna to Greece, of Beirut to France, and of Trezibond to Armenia together with the inclusion of Haidar Pasha in the zone of the

Straits and the special régime of Constantinople (with its tributary territory in Europe reduced to the needs of water and vegetable supplies) placed practically every outlet of Turkish trade in foreign hands.

TABLE I—COMMERCE OF THE PRINCIPAL PORTS OF THE TURKISH EMPIRE (1910–11)

(*Percentage*)

	IMPORTS	EXPORTS
Constantinople	31.48	9.00
Smyrna	10.87	20.60
Saloniki	10.64	5.04
Beirut	9.98	4.66
Haidar Pasha	Total of 5.94	
Trebizond	2.24	1.28
Dedeagatch	1.65	1.82

Total value of exports in 1910–11	$80,000,000
Total value of imports in 1910–11	150,000,000

Were the interior of Turkey a closely organized agricultural unit the loss of coastal outlets might have been less serious. On the contrary, the arable lands of the peninsula lie for the most part near the sea in patches and narrow belts or tongues of valley floor or on the lower soil-covered hill slopes. Elsewhere, and notably in the steppe-like interior, the pastoral-nomadic type of life prevails. Because this life is on a more primitive level than in Europe it follows that the Turk could afford to waste his land and people without fearing for their future if he could in the end recover the coastal outlets.

Moreover, another geographical element enters into the present situation. The Turk has been fighting on his own distant ground, and the Allies have had to come to him; and that is costly. Here time has told on the side of the Turk. It was, therefore, logical to conclude that the Treaty of Sèvres and the supplementary Tripartite Agreement of even date (1920) between Great Britain, France, and Italy would have no validity at all unless the Turk agreed. The Allies could not force him to accept their terms.

TURKEY'S TERRITORIAL GAIN IN THE ANGORA AGREEMENT

The first step in Turkey's territorial advancement over the Treaty of Sèvres was made in the military confines bordering northern Syria. Down from the northeast runs a string of valleys towards salt water at the Gulf of Alexandretta. By the Treaty of Sèvres France encircled that outlet, whence a considerable trade reaches the coast and where fertile lands already productive are susceptible of still greater development. It is not a principal Turkish outlet, but it is an important one. By the Angora Agreement (1921) it was recovered by Turkey though France still retains an economic priority in the vilayets of Adana, Diarbekr, Sivas, and Kharput—virtually the French zone of the Secret Treaties and of the Tripartite

Agreement. Of chief importance in the region is the Cicilian plain. While the northern part is gravelly and dry and supports a population chiefly nomadic, the southern half has a fertile soil abundantly supplied with water available for irrigation. In recent times Egyptians, Syrians, Bulgarians, and Circassians have colonized it and notably displaced the old Turkish population.[5]

Smyrna, Constantinople, and the Straits

As soon as the Angora Agreement had gained them the first of their essential outlets the Turks turned to Smyrna. Smyrna is far and away the largest export port of the Turkish realm. Besides it is the center of one of the few really dense populations of Turkey. Nothing could be more certain either from the historical or the commercial standpoints than that it would become one of the chief objectives of the Turkish army. With Smyrna in his hands Mustapha Kemal Pasha turned to Constantinople; and, though he had no fleet, it was obvious at the beginning that he would try to enlarge his European holdings and get control of Constantinople also as a basis of negotiation and compromise. By this act he would regain the capital and the greatest importing city of the Turkish Empire. Second only to the recovery of Constantinople as a symbol of power and prestige throughout the Mohammedan world is that of the European hinterland—eastern Thrace with Adrianople. Before the Turk had reached the Golden Horn, Adrianople had been his European capital. In 1913 Turkey had put forth her "historic rights" to the city and had recovered it by agreement with Bulgaria at the close of the Second Balkan War, thus modifying the Enos-Midia line upon which they had agreed at the close of the First Balkan War.

The present situation finds the Allies not unprepared for concessions. In March, 1922, the Allied Ministers at Paris had already proposed substantial departures from the Treaty of Sèvres. Two prime objectives were, however, retained—protection of Christian minorities and freedom of the Straits. In this last point lies the crux of the entire situation. Unlike the other territorial questions this of the Straits is primarily of international importance. Attention has already been called to the economic value to Turkey of the western waterways of the old Empire, in particular of the ports of Smyrna and Constantinople, but there is also the trade of the Straits distinct from that of the bordering ports. The Straits is one of the great maritime passages of the world. Up to 1910 the movement of shipping surpassed that through Suez.

Thrace

The debatable ground of Thrace has long been a political storm belt. Turk, Bulgar, and Greek meet there in an environment that offers something congenial to all three races. The present division of territory is only

[5] Ewald Banse: Die Türkei: Eine Moderne Geographie, 3rd edit., Brunswick, 1919, p. 175.

the last of a long series made to establish boundaries where no natural or ethnic divisions in truth can be found.

Elsewhere in the Balkan Peninsula two (or rarely three) powers have been in conflict over disputed territory, whereas in Thrace at least five groups of interests are in conflict. Greece has sought to encircle Constantinople and shut off Bulgaria from the Aegean as well as Turkey from Europe. Bulgaria has persistently sought a territorial and commercial outlet to the Aegean on the south. Turkey has resisted both Greece and Bulgaria, and in 1920

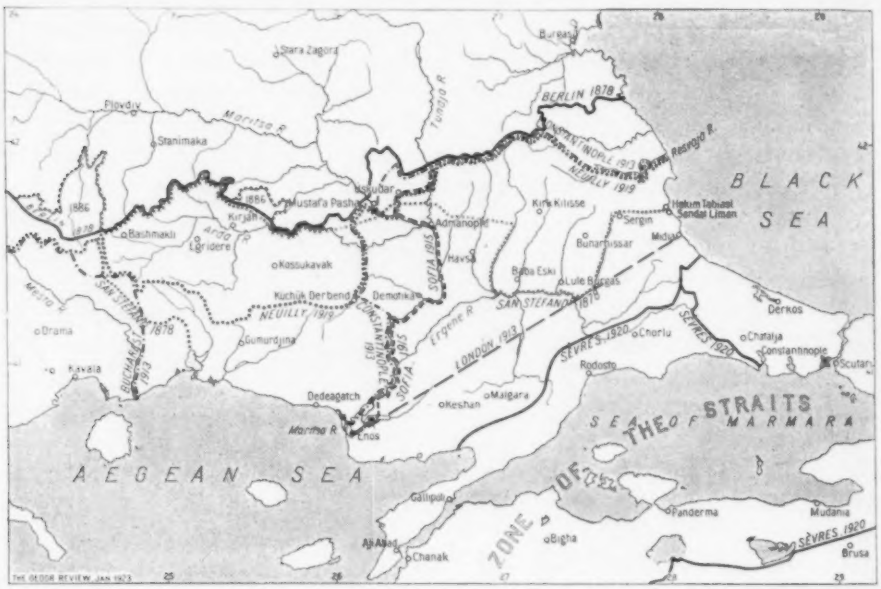

FIG. 4—Sketch map illustrating the political geography of Thrace. Boundaries established by the following treaties are shown: San Stefano, 1878; Berlin, 1878; London, 1913; Bucharest, 1913; Constantinople, 1913; Sofia, 1915; Neuilly, 1919; Sèvres, 1920.

the Powers put into force a special régime for the Zone of the Straits that introduced a fourth group of interests. The trade of Russia gives her also a primary interest as a fifth power.

The positions of the various treaty lines are geographically interesting. The line of San Stefano followed natural features in western Thrace; in eastern Thrace it would have produced serious dislocations in the life of that time, because it cut across the grain of the country owing to the absence of dominating natural features that run in an east-west direction. The Treaty of Berlin that superseded it put the line in a more natural position, in closer relation to minor watersheds northeast of Adrianople while still retaining the natural features of river (Arda) and mountain crest (Black Balkans) in western Thrace for a considerable distance. The Treaty of Constantinople between Bulgaria and Turkey (1913) provided for a frontier on the Maritsa River for a short distance above its mouth. It then

ran west of north, cutting across drainage and relief in such a way as to encircle Adrianople at a distance, while it gave Bulgaria on the border of the Black Sea a block of territory whose southern margin followed the Resvaja River. The changes stipulated by Bulgaria in 1915 as part of the price of her entry into the World War placed her frontier on the Maritsa River opposite Adrianople and also gave her ownership of the *left bank* of the Maritsa. The border of the Zone of the Straits and of the Constantinople zone of the Treaty of Sèvres on the north side of the Sea of Marmora took advantage of natural features only to a limited degree, for the special régime under which these two territories were to operate was itself designed to provide flexibility of frontier arrangements.

The Turkish victories of the past few months have brought the Turk into the problem again. Further modification will come no doubt both here and in northeastern Turkey where the Armenian boundary was projected and where the State of Kurdistan was outlined by the Treaty of Sèvres.

At the present writing (Dec. 2, 1922) the question of Mosul and its oil fields has also been brought into the Turkish settlement. The British mandatory area, as at first proposed, encircled the oil district and this position was incorporated into a treaty (Sèvres) only when France had relinquished an overlapping territorial claim in return for the privilege of securing one-fourth of the oil produced in Mesopotamia. France also gave the British the right to build oil pipe lines to the Mediterranean across the French mandatory area in Syria in return for the privilege of buying one-fourth of the oil that may be piped in this way from Persia.

The agreements between France and Great Britain, mentioned above, were all based upon the supposition that Turkey would sign the treaty of Sèvres. But the recent Turkish successes have definitely put that treaty aside and also reopened the question of oil; just as in northern Syria the Turkish successes of 1921 obliged the French to modify their limits of control about the head of the Gulf of Alexandretta. The problem can hardly be expected to be solved without further changes in the political map of the Turkish Empire, since irrigation possibilities, oil reserves, and strategical considerations make Mesopotamia a highly desirable block of territory—to the British, with Egyptian and Indian territory on either hand and an oil-burning navy, no less than to the Turk trying to piece out his national domain and recover some part of his former economic strength.

Traversing the British and Turkish interests are those of Mesopotamia (Iraq) itself. If King Feisal looks at the political map and gives a thought to oil and irrigated land and trade routes he may well become a deciding factor. In any event the political geography of the Near East promises to have more rather than less significance as the underlying causes of boundary changes come one by one to the front.

FUTURE WHITE SETTLEMENT: A REJOINDER

By Griffith Taylor

In response to Professor Willcox's comments in the October (1922) number of the *Geographical Review* on my article, "The Distribution of Future White Settlement," I wish to state that:

1. With regard to extending the wheat boundary in the future, the same unconvincing argument crops up in Australia. Wheat culture may be pushed forward many miles into the arid or cold regions owing to scientific research. But I would ask my critics *to plot* on a map the increased areas thus gained. I think they will see that these new regions of moderate and somewhat precarious crops *bulk very little in comparison* with the optimum belts; which latter, moreover, will probably be *growing in importance* while the outer fringe is advancing. Such crops do not essentially affect the *vast areas* unsuited for agriculture. (It is not, I think, legitimate to quote extensions in the past made before the climatic controls of wheat were fairly understood.)

2. I fear that I still hold that the health (including also in this term the idea of a *comfortable* existence) of the white race is, and will be, much more controlled by climatic factors than by "individual family and social action."

3. I regret that I did not clearly quote my authority for my statement that the world's population has doubled in the last ninety years. Mr. Willcox rather gratuitously assumes that I had no basis for this statement. If, however, he will turn to the report which I quoted seven lines further on, he will find that the Commonwealth Statistician (on page 33) discussed this problem and shows graphically that the world has doubled its population from 1820 to 1920.

4. My answer to the comments on the growth of population of the United States is that I am the last person to imagine that one can accurately foretell the world's population in 200 years. Hence it seems superfluous to apologize for the small differences between the figures (expressly termed "approximate") which I quoted (25, 50, and 100) and the more accurate figures, (23, 50, and 92), which I am willing to accept. The difference falls well within the "error of the experiment," but the main argument is not greatly affected.

5. The declining birth rate as a potent factor in the problem is expressly mentioned in the last paragraph of my paper. Hence I think that the chief difference between Mr. Willcox and myself is that he does not yet fully appreciate the importance of the physical environment, whereas I can see no reason to doubt that it will continue to be the chief agent in determining the habitats of the human races.

GEOGRAPHICAL RECORD

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of November and Elections to Fellowship. The first regular monthly meeting of the American Geographical Society for the season of 1922–1923 was held on November 21 at the Engineering Societies' Building, 29 West Thirty-ninth Street. President Greenough presided. There were presented with the approval of the Council the names of 375 candidates who were duly elected as Fellows of the Society. The Society was then addressed by Mr. Carl E. Akeley, of the American Museum of Natural History, on "The Gorillas and Volcanoes of Kivu." The lecture was illustrated by moving pictures taken on his African expedition of 1921–1922. Mr. Akeley is inventor of the Akeley moving picture camera and a former president of the Explorers Club.

On December 26 Dr. Charles Upson Clark will address the Society on "Transylvania: the Rumanian Switzerland."

Dr. Clark visited Rumania in 1922 for further studies. He is the author of a book entitled "Greater Rumania." Fellows of the Society will remember his extremely interesting lecture on Rumanian life and geography in 1920 and his lecture of 1918, "Fighting Above the Clouds." For several years Dr. Clark was Director of the School of Classical Studies of the American Academy at Rome.

Recent Publications. A little more than two years ago the Society resumed its full program of publication and is able to announce fourteen monographs and two maps now available for distribution. Among these is a timely book entitled "The Earth as Seen from the Air," by Willis T. Lee of the U. S. Geological Survey. There are nearly seventy airplane photographs and a number of maps. It represents a year's work of which a large part was spent in the field under highly favorable conditions of flying. The book is printed on heavy coated paper in large type and bound in heavy gray covers with black panel. It is a contribution of the first order to what may be called airplane geography.

In the study of man it is important to know his relation to past climates that affected his way of life and geographical distribution. The records of history contain part of the story, the rings of growth of the Big Trees of California contain another part. What is now needed is to connect these elements with the latest phases of the great Ice Age. Baron Gerard De Geer discovered that this could be done in Scandinavia by studying the thickness and sequence of layers of clay deposited in fresh-water lakes now extinct; and his pupil, Dr. Ernst Antevs of Stockholm, has applied De Geer's methods in New England with the result that we now know that it took over 4000 years for the great continental glacier to retreat from Hartford, Conn., to St. Johnsbury, Vt. The method and the results are published in "The Recession of the Last Ice Sheet in New England," illustrated with photographs, graphs, and a colored map.

When England and Spain were building their great colonial empires in the West, Peter the Great of Russia was encouraging the exploration of the vast spaces that lay between the Urals and the Pacific. In his service, Vitus Bering, a Dane, was appointed leader of a great expedition that was to lift the veil that lay over the northeastern edge of Asia and the northwestern corner of North America and to place upon the charts for the first time the coastal outlines of the region and establish the true relation of Asia and America. The official records of Bering's two expeditions have never had adequate publication in English. Bering's report on the first expedition, the journal of the companion vessel, the St. Paul, by Chirikov, his second in command, as well as five chapters of text description and comment, are published in a book entitled "Bering's Voyages." These documents relating to the second expedition are published for the first time, having been translated from the originals in the Russian archives. There are included manuscript maps and unpublished drawings of Aleuts, from the Russian archives, and a facsimile of Peter the Great's orders for the first expedition, with comments in his own handwriting. The book contains a chart of the second expedition, in 1741, based on the log books. This is a modern reconstruction of the tracks of

the two vessels of the expedition adjusted to the actual lay of the land, which had never been done before for the whole voyage. A companion volume under the same general title will be published in 1923 and will contain the account of the sea voyage on the second expedition by G. W. Steller, the naturalist of the expedition.

In the same year that the Society published "Bering's Voyages," relating in large part to the coast of Alaska, it had the appropriate task of compiling and drafting a map of Alaska for the Alaska Road Commission. The map is on the scale of 1:1,250,000, or about 20 miles to the inch. It measures about 60 by 50 inches over all and is printed in five colors. It has been compiled from at least 170 principal sources and is a great advance over any existing map of the territory. It shows contours so far as they have been determined, railroads and various classes of roads and trails, telegraph and wireless stations, lighthouses, and national forests and parks. It will serve in the development of Alaska's resources of coal and oil, forests, reindeer meat, water power, and the like. It will also serve the tourist and mountain climber.

A second map produced in 1922 is the La Paz sheet of the Millionth Map of Hispanic America. It is printed in twenty-two colors. It includes the disputed Tacna-Arica area on the common frontier of Peru and Chile, takes in the Maritime Cordillera of northern Chile and Cordillera Real of Bolivia and the high plateau between with its salt marshes and interior drainage, and a portion of the Pacific floor in an abyssal region, the Krümmel Deep. It conforms in most respects with the International Map of the World and is the first of 100 sheets which together will constitute a great atlas of the Hispanic American realm.

The La Paz sheet is accompanied by a handbook entitled "The Geography of the Central Andes" by Alan G. Ogilvie of the staff of the Society. It contains 250 pages and has two large maps of population and the use of the land on the scale of 1:2,000,000, besides 41 photographs and sketches. The book represents modern standards in regional description and deals with plant and animal life, minerals, climate and soil in relation to the life of Highland Bolivia and the adjacent lowland on either side, one wet tropical and the other coastal desert. The cartographic sources of the La Paz sheet are given, and there is an extensive bibliography.

The collections of the Society include a considerable number of rare maps and books of importance in the field of historical geography. On account of its rarity and value, one of these items was reprinted in 1922. It is entitled "A Short Account of the First Settlement of the Provinces of Virginia, Maryland, New-York, New-Jersey, and Pennsylvania." Only seven copies of the original are known; two in the Harvard College Library, one in the Library of Congress, two in private possession, one in the Newberry Library at Chicago, and one in the library of the Society. The booklet was printed in a limited and numbered edition on handmade paper, in original Caslon type, and included a facsimile reproduction in color of Captain John Smith's map of 1606, with extensions by John Senex accompanying the original. It gives a brief narrative of the progress of sixteenth and seventeenth century settlement along our Atlantic seaboard.

Two publications of special interest to scholars deal with bibliographical matters. The first is entitled "Bibliographical Aids in Geographical Research," by Dr. John K. Wright, the librarian of the Society. This book aims to help the student of geography in his search for printed material. It is a critical guide to various bibliographical tools and periodicals of geography and of its allied natural, historical, and economic sciences. Sections are also devoted to general bibliographical reference books and to guides to government publications and maps.

The second item grows out of the program of research of the Society in the field of Hispanic American geography. It is entitled "A Catalogue of Geological Maps of South America," by Henry B. Sullivan of the U. S. Geological Survey. It includes a technical description of over two hundred geological maps and is accompanied by an index map of the geological maps of South America which shows the position of each one on the continent. Alternate pages are left blank for additions by the user and for notes on the maps themselves.

There has also been prepared a "List of Maps of Hispanic America: I. Maps Contained in Periodical Publications." It consists of a typewritten list of maps arranged by countries and is bound in octavo.

Distribution of Title Page, Contents, and Index of Volume 12 of the "Geographical Review." The title page, table of contents, and index for Volume 12 of the Geographical Review (1922), which is issued separately, is ready for distribution. Copies are sent to all

institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

NORTH AMERICA

Aboriginal Geography of New York State and City. Two recent books devoted to the aboriginal archeology of New York state and city contain materials of distinct geographical interest. The first, by Arthur C. Parker, is entitled "The Archeological History of New York" (*New York State Museum Bull. Nos. 235–236*, July–August, 1920, Albany, N. Y., 1922). A background is supplied by a brief survey of the origins of early man, his probable course of migration from the Old World into the New by way of Alaska, and his distribution throughout North America. An important chapter is devoted to the "Physiographic Features [of New York] Inviting Occupation:" particularly the easy communication by water and land, the abundant supply of food, and the climate which by the warmth of its summers admits of abundant harvests and by the cold of its winters conduces to mental and physical vigor. Mr. Parker thinks it no fortuitous circumstance that New York state should have been held by the most able mentally of all the North American tribes. Physiography influenced the location of Indian trails and town sites. The level lines of abandoned lake beaches were the natural routes for trails, destined to be followed, when the white man came, by wagon roads and railways. At convenient landing places and portages Indian settlements sprang up, often the precursors of modern towns and cities.

The artifacts collected throughout New York show evidence of several different stages of Indian occupation prior to the coming of the Iroquois, perhaps some 600 years ago: Eskimoan or "Algonkian tribes intermarried with the Eskimo"; Algonkians; and peoples of cultural affiliations with the mound builders of Ohio (about whom there has been much far-fetched speculation). By means of sketch maps Mr. Parker shows the areas influenced by the material cultures of these various folk. The Algonkians seem to have followed the main watercourses throughout the length and breadth of the state; the people of mound-builder culture kept to stream and lake shore in the center and west; Iroquois civilization also predominated in the western half of the state, though Iroquois remains have been found generally throughout, except in the Adirondack wilderness, which seems to have been consistently avoided by red man and white man alike. Mr. Parker thinks that the Iroquois came to New York from the southwest, possibly from the lower Ohio valley.

Reginald Pelham Bolton's "Indian Paths in the Great Metropolis" (Indian Notes and Monographs, Museum of the American Indian, Heye Foundation, New York, 1922), will delight all students of the local topography and antiquities of New York City. From archeological remains, historical records, old maps, and inference Mr. Bolton has succeeded in reconstructing and plotting upon a series of maps the probable routes followed by the Indian trails of Greater New York and its environs. These trails "ran not only between the several stations of a single tribe or chieftaincy, but were highways of communication between very diverse peoples." Manhattan Island seems to have been a natural nodal point toward which the Indian routes converged from all directions. The detailed track of these routes was determined by conditions of terrain, the shortest distances consistent with the avoidance of obstacles, particularly marshland and steep grades. When the early white settlers arrived, they built their wagon roads along the lines thus marked out, and these early roads were often followed by post roads and by the main arteries of automobile traffic of the present day. Broadway and the Boston Post Road as they approach Manhattan from the north and northeast are lineal descendants of Indian paths in the forest. These joined at a "wading place" through Spuyten Duyvil Creek where Broadway now enters Manhattan Island. Thence a trail ran down the whole length of the island to settlements at its southern extremity whence there was an easy ferry over to the Long Island shore. Some parts of this longitudinal trail are represented at the present day by certain of the main highways of New York, notably St. Nicholas Avenue, the Bowery, and lower Broadway from Fulton Street to the Battery.

The Wilderness Road to Kentucky. There is no trail in America more deeply associated with all that is characteristic and significant in American life than the Wilderness Road which lay between Virginia and Kentucky. Boone blazed it in 1775 on the basis of the best information gleaned from explorations of his own and of others. It was, for nearly three

decades, the main channel of communication between the seaboard states and the new settlements in Kentucky. Then its importance waned.

The reason for its rise and fall lay in the fact that it was an adaptation to a peculiar situation. The American frontier had been pushed west to the mountains beyond which beckoned the great fertile areas of the Mississippi valley. There were easier passes across the mountains than the Wilderness Road. One was the Mohawk valley, later to become the greatest of all, but in Boone's time it was blocked by the powerful and warlike Iroquois. There were roads across Pennsylvania to Pittsburgh at the origin of the Ohio. Many used these in going out to Kentucky; but the uncharted river was dangerous, and in the country north of it lived the Indians that Wayne fought at Fallen Timber and that Tecumseh gathered into an ill-fated confederation on the eve of our second war with England. Moreover, the journey eastward from Kentucky to Pittsburgh was against the current. The country on the west of the southern end of the Appalachians was dominated by the warlike Cherokees, kinsmen of the Iroquois. Between these southern Indians and those of the Ohio and Indiana country lay Kentucky, a neutral ground.

Kentucky was, therefore, the place of the first important American settlements west of the mountains. Long and difficult though it was, the Wilderness Road was practically the only feasible route to the west. Over it went most of the men and women and most of the goods that made civilization beyond the mountains possible. Its importance lasted until the power of the Indians was broken at Newtown and Fallen Timber, Tippecanoe and Horseshoe Bend. Then better routes across the upland barrier could be utilized. Today it is off the beaten track, and some of its stretches have long been abandoned. But to its name still clings the memory of those thousands of pioneers, making their way with fear and hope through the long two hundred miles of mountainous desolation to the homes that were to be in the plains beyond.

Three times has the history of the trail been written; but it has remained for a physician, William Allen Pusey, to determine as nearly as possible its exact location. His work has been thoroughly done, and his book, "The Wilderness Road to Kentucky" (New York, 1921), makes a lasting contribution to the literature of the historic highway. He has plotted on topographic maps of the U. S. Geological Survey the small details of practically the whole of the route. Numerous illustrations and an illuminating text give vividness to the book; but the lack of an index is regrettable.

An interesting sequel to the story of the Wilderness Road may be found in "The Natchez Trace," by R. S. Cotterill, in the *Tennessee Historical Magazine* for April, 1921 (issued June, 1922). The products of the early Kentucky settlements beyond what were needed at home were floated down the Ohio and the Mississippi to New Orleans, the mountains preventing their carriage eastward. Some products went in keel boats that could be poled laboriously back up the river, but most floated down in great flatboats that were broken up and sold for lumber at the journey's end. The boatmen who handled them made their way on foot or on horseback back to "Kaintuck" along the "trace" from Natchez throughout the country of the Chickasaws and Choctaws to Nashville and from Nashville to Lexington. This trail with its drinking, fighting bands of boatmen, "half alligator and half horse," according to their own proud boast, had its own picturesqueness. Its story preserves a phase of American life that passed with the frontier.

RALPH GABRIEL

The Inland Lakes of Michigan. Five thousand has long been the round number accounting for the inland lakes of Michigan, whose exact number is still not definitely known. It is estimated that these bodies of water, varying in area from a lake of some thirty-one square miles to a pond too small to be named and forming but one among seventy in an area of a single square mile, occupy about one-fiftieth of the total area of the state, or about 12,000 square miles. If they were drained they would add much valuable land to the acreage of the state. As it is, however, many are a valuable asset. One thinks first of Michigan's fame as a summer resort and as a fruit-growing state: for each of which no small credit is due to the modifying effect upon atmospheric temperature exercised by this host of small lakes, overshadowed though they may be by the influence of the Great Lakes. Of lesser and more local importance is the service which these lakes perform as natural reservoirs accommodating, with only a slight increase in level, the waters of the spring freshets and lessening thereby the flooding of tributary streams and the stripping of the soil. Added to this is the local use for power, irrigation, and city water supply effected by damming the outlets.

A study of any of these lakes, whether for scientific interest or utilitarian purposes, would necessarily include the origin of the lake, the action of wind and wave and ice on its shores, the possibility of extinction by vegetable growth or developing drainage. The basis for such a study is given by Professor I. D. Scott in "Inland Lakes of Michigan" (*Michigan Geol. and Biol. Survey Publ. 30, Geol. Ser. 25*, Lansing, 1921). The monograph includes a general study and classification of the inland lakes of Michigan and treats several examples in detail.

The present surface features of Michigan are largely due to a veneer of drift left by the last ice retreat. The lakes of the state are predominantly of glacial origin, and their existence is an indication of the present incomplete drainage of this morainal veneer. Physiographically Michigan is divided into seven natural regions. In the Northern Peninsula are the Western Highland, which averages 1000–1200 feet above Lake Superior; and the Eastern Lowland, averaging more than 1000 feet lower than the highland. In the Southern Peninsula the physiographic provinces have a southwesterly-northeasterly diagonal trend. In the southeast is the Lake Erie Lowland, bordered to the northwest by the Thumb Highland. Bordering this Highland is the Saginaw Lowland, running from Saginaw Bay southwest to the central part of the state where it meets the Michigan Lowland which follows the lake for some distance north and south. The two form a great lowland belt across the state and are bordered on the north by the Northern Highland. In both Northern and Southern Peninsulas the lakes are largely confined to the moraines of the lowland provinces.

At least six types of lakes of glacial origin have been noted. There are also, as might be expected in a state with so much shore line, many lagoons. In addition is a much lesser number of lakes of diastrophic origin, mainly rift-valley and ponded, and, along the river courses, the familiar oxbow lake.

Nitrate Deposits of Southeastern California. There have long been rumors of the existence of workable nitrate deposits in the arid regions of the West. Scientific investigation of reported occurrences received a great stimulus during the war, and a result is the recently published "Nitrate Deposits in the Amargosa Region, Southeastern California" (*U. S. Geol. Survey Bull. 724*, Washington, D. C., 1922), an examination of one of the most promising localities.

The Amargosa River enters Death Valley by a long, open basin that may be considered as a southward extension of the valley. Nitrate beds occur in a narrow belt along the southwestern margin and also farther upstream where in places the valley assumes a canyon aspect. The deposits are associated with clay beds of Tertiary age deformed since deposition and now outcropping in more or less isolated hills whose light color and rounded contours contrast strikingly with the rugged and highly colored mountain walls enclosing valley and basin. The nitrate is found in the *caliche* layer lying beneath a superficial soil covering and somewhat similar to the *caliche* of the Chilean fields. It is thus quite distinct from the widespread but valueless deposits of so-called "cave" nitrates.

The investigation shows that nitrate is present in extractable quantities but that under existing conditions it could not be worked in competition with the Chilean product. The higher grade deposits are patchy and scattered, and even in these the percentage of nitrate is low. In addition to difficulties of transportation and mining imposed by the topography, there would be seasonal limitations on systematic exploitation. In the article "Death Valley—the Hottest Known Region" (*Monthly Weather Rev.*, Vol. 50, 1922, pp. 10–13) A. H. Palmer gives an account of the climate of Greenland Ranch, an irrigated spot on the eastern edge of the Valley. During the decade 1911–1921 the mean temperature of June was 94°; July, 101°; August, 99°; September, 89°. In July and August the mean maximum temperatures were 115.7° and 114° respectively, and the extreme maximum was 134°. It is believed that this is the highest natural air temperature on record as an undisputably reliable observation.

EUROPE

The Character and Origin of the Frisian Islands. The March, 1921, issue of *Annalen der Hydrographie und Maritimen Meteorologie, Zeitschrift für Seefahrt- und Meereskunde* contains a discussion, by Dr. Walter Behrmann, of the character and origin of the Frisian Islands. From the Channel to the Jutland coast the North Sea is framed by a wall of sand dunes fringed by a sandy beach gradually descending into the sea. From Calais to Blankenberg the wall is unbroken except for the mouths of a few streams. Even where the Rhine

makes a very wide breach the islands of Walcheren, Schouwen, and Goeree remain to indicate the presence of the wall. At the Hook of Holland the wall closes again and curves unbroken as far as The Helder. There the wall breaks again to form the Frisian Islands. Coast and islands bend in a smooth curve from a north-south direction to east-west and then back to north-south again. Juist and Nordeney, however, do not follow the curve but thrust out northward into the sea.

Two problems are suggested: (1) the origin of the material from which the dunes are built; (2) the agent which has caused the breaches in the wall. The natural answer is that the material is either river sediment or the products of wave erosion brought from the French or English coasts, while the breaches are formed where rivers empty into the sea. The dunes, however, consist of layers of pure quartz sand separated by layers of sea débris—slag from English furnaces, coal dust from passing ships, seaweed. The sediment carried by the Rhine and other rivers of the region is mud, not sand. The seacoasts which might furnish the material are chalk cliffs. Also, the suggestion that river mouths have caused the breaks in the wall does not explain those breaks where there is no river mouth.

Dr. Behrmann finds an apparent solution in the dunes of Heligoland which consist of a sand hook so protected by the island that no material brought by the waves could reach it. The material which forms this hook, he considers, is from the sea floor itself, which he believes and which soundings show is covered by the same glacial drift that forms the North-German plains. It is well known that storms stir this part of the North Sea to a grayish color, the color of quartz sand in suspension. During the war this gray color was an indication of the whereabouts of submarines lurking on the sea bottom. This suspended sand is built into dunes not during storms when the action of the waves is destructive rather than constructive but in the lull after the storm while the sand is still in suspension. Each little wave then brings its load and, as it falls back with its momentum retarded, deposits part of that load. The tides play an important part, the deposition being greatest at the ebb.

As to the formation of the breaches in the wall: the west winds bring two currents into the North Sea from the Atlantic by way of the channel between the Shetland Islands and Faroes One enters along the Norwegian coast, the other along the Scottish. A third current, entering by way of the Channel, gives to these a circular motion whose direction south of the Frisian Islands is coastwise so that its action, except in time of storm, is constantly one of gentle deposition, whereas in the Frisian Islands the direction of the current is toward the coast. As a result the breaches made by storms are kept open and enlarged while the islands themselves, beaten upon by the storms, have a high dune on the west and a sloping beach on the east. Dune and slope move constantly slowly eastward.

Irrigation in the Alps of Piedmont. *La Geografia* for May–August, 1922, contains a study by G. Roletto of irrigation in the Alpine valleys of Piedmont between the northern watershed of the Dora Riparia valley and the southern watershed of the Val Varaita. The writer's purpose is to correlate the physiographic facts of this region with the distribution, density, and character of irrigation and these, in turn, with the outstanding elements of the economic life. The details of these correlations are of purely local interest, but from them emerge certain generalizations to which it seems worth while to call attention.

Irrigation is here necessary partly because of the highly permeable glacial and other formations which underlie so much of the productive land and into which the water is rapidly absorbed, and partly because of a relatively low precipitation during the summer months—the growing season of meadow and field crops. The valley floors fail to offer broad enough expanses of meadowland to produce sufficient fodder to last through the winters. Consequently at as early a period as the Middle Ages the peasants were obliged to seek for upland meadows and pastures and, in order to make these productive, to construct elaborate systems of irrigation. Though many of the latter have been abandoned of late years, the essential fact of irrigation at widely diverse levels still prevails in association with the seasonal migration from the valleys to the heights which is such a striking characteristic of Alpine pastoral economy (see Philippe Arbos: La vie pastorale dans les Alpes Françaises, Paris, 1922).

The upper level of existing irrigation in this part of Piedmont corresponds generally with the upper level of permanent habitation, diminishing from elevations of 1800 meters back in the mountains to 300 where the valleys open out upon the plains. The intensity of irrigation in relation to the total agricultural production, to the areas of meadow, pasture, and cultivated field, and to the density of population varies widely from place to place but bears

an intimate connection with local conditions of slope, drainage, soil, etc., on the one hand, and with various demographic factors on the other. In the valleys, where the intensive cultivation of fields prevails, there are broader surfaces under irrigation in proportion to the population than on the slopes and uplands. The zone of cultivated fields is also the zone of the lowest percentage of emigration.

There is little uniformity in the customs and usage of irrigation. Proprietary rights are vested here in the users of the water, there in private individuals, elsewhere in the communes. There is an immense diversity of regulations governing the utilization of the water. Throughout large areas no fixed times are set when the water is distributed; in other localities this is done once a week, elsewhere on holidays, still elsewhere every fifteen days, and so on. The customs of nomadism are also multiform and are divided by Roletto into no less than four main types and several subtypes.

The irrigation and consequent use of remote meadows and pastures have led to the construction of storehouses or barns (*grange, ciabot*) for the temporary accumulation of the fodder before this is finally carried to the permanent villages to be stored for the winter. At the present time many of these barns are being abandoned. One reason for this is the improvement of roads and other lines of communication which make it more convenient to transport the crops directly to their final destination, but a more potent cause is "the slow but inexorable descent of the pastoral population toward the valleys" and consequent relinquishment of the exploitation of the high meadows and of human constructions connected with them. Roletto acknowledges in his conclusion that here, for the time being at least, man is losing ground in his everlasting struggle with environment. This ground may perhaps be regained and a great future may lie in store for these valleys if the example of Switzerland be followed, where the impounding of water for purposes of irrigation has been utilized in conjunction with the development of waterpower.

AFRICA

The Census of 1921 in French North Africa. The beginnings of the modern French colonial Empire may be said to date from the capture of Algiers in 1830. Thence French control has been extended east, west, and south, culminating in the recent establishment of connections with West Africa across the Sahara. There is thus created a solid French block in northwest Africa with a population estimated at 25,000,000 to 26,000,000, over three-fifths that of France. French North Africa (Algeria, Tunisia, Morocco) accounts for half this figure according to the census of 1921. Two main interests are manifested in the detailed results of the census—the number and distribution of the total population, regarded as economic and military assets, and the number of the European element in this total population (Augustin Bernard: Le recensement de 1921 dans l'Afrique du Nord, *Ann. de Géogr.*, Vol. 31, 1922, pp. 52–58 and note, Vol. 31, 1922, p. 382; Raymond Peyronnet: À propos du recensement de 1921, *Bull. Soc. de Géogr. d'Alger et de l'Afrique du Nord*, Vol. 27, 1922, pp. 340–359).

The total population of Algeria is 5,806,090, representing an increase of 2.5 per cent over that of the last decade. This disappointingly small increase is explained as a consequence of the war, followed by the famine of 1920, though this was far from being as serious as that of 1867. During the period 1876–1921, following the introduction of direct administration, the native population doubled. In some sections, notably in parts of overpopulated Kabylia, the population density is equal to that of Belgium; but the desert territories of the south have a thin population (546,000 on an area of 850,000 square miles. Cf. "Les Territoires du Sud de l'Algérie," 2 vols., Gouvernement Général de l'Algérie, Algiers, 1922), and the country as a whole could support a much greater number of people. Algiers, the largest town, has over 200,000 people, Oran 146,000, Constantine 78,000. There has been a distinct movement both of natives and Europeans to the towns from the *bled*.

Tunisia, where a census of the native population has been taken for the first time, has a total population of 2,093,939. Tunis, the one large town, has over 200,000.

Much criticism has been made of the census results in Morocco. The difficulties of census taking among the rural population are obvious enough, and there also appear to be discrepancies in the town populations. Thus the census gives Fez only a little over 70,000, when it is generally regarded as a town of 100,000. The figure for Casablanca, 101,690, does not take account of a considerable floating population. Marrakesh, the center of one of the most populous districts, has 102,100. The total native population of the French zone

is considered to be not more than 4,500,000—a lower figure than has been credited. For the Spanish zone and Tangiers estimates range from 500,000 to 1,500,000, some authorities attributing to the Rif a much denser population than has been supposed.

The European population of Morocco is estimated at 144,000. The number in the French zone is 62,000 and is almost exclusively urban, half the population residing in Casablanca. The situation is of course different in Algeria, which is administered as an integral part of France, and in Tunisia, both of which countries have been the object of a definite policy of European colonization. Tunisia has 156,000 Europeans, the ratio with the native population being 1 : 13; Algeria has 830,000, the ratio being 1 : 6. These figures, however, are not considered satisfactory, particularly in view of the differential increase of the various races. It is estimated that under normal conditions the annual increment of the French (in origin) population is 3,000; of the other European elements 6,000; of the natives 60,000. The question is whether France can retain her hold over the great and increasing Mohammedan population. The loyalty of this population during the war and the peace in French North Africa is frequently contrasted with conditions among the Mohammedan population of Egypt and India. But with her stakes in the Near East the future is none too sure for France. A widely held view of the need of French West Africa is expressed in the words of a former governor of Algeria: "Si nous ne peuplons pas l'Afrique du Nord, nous ne la conserverons pas"; and by M. Augustin Bernard in his article in the *Annales de Géographie:* "Nul problème à l'heure actuelle n'est plus important pour notre pays que le peuplement français rural de l'Afrique du Nord."

A particularly disturbing feature of the situation is the movement of the European element from the country to the towns. In Tunisia the area of European holdings has suffered a decline of 58,000 hectares from 1914 to 1921; in Algeria land purchases by Europeans during this period have been only slightly in excess of sales.

With her low birth rate France has little population to spare for colonizing. As it is, only about half the colonists are of French origin; Spaniards are particularly numerous in Oran, Maltese and Italians in Constantine and Tunisia. The chief hope of colonization lies in increasing the numbers of these and other European peoples—immigration of the prolific Czechs and Poles is advocated—in spite of a certain danger apprehended in the possible creation of large groups of foreign nationality. Prospective colonists, however, must be assured of land or work; and, if a government program of immigration be initiated, it must be correlated with plans of land development, which in Algeria and Tunisia would especially have reference to water supply for agriculture and in Morocco to means of communication. Some fears also have been expressed regarding the social and political status of the colonist in Algeria since the passage in 1919 of a bill increasing the native franchise and facilitating the admission of natives to French citizenship.

The Aures Massif as a "Cultural Island." In his discussion of the population of French North Africa appearing elsewhere in this number of the *Review* Professor Gautier briefly describes the Aures massif of eastern Algeria (see map, p. 29). An account of ethnographical studies among the people of this "cultural island" forms the subject of a recent book, "Among the Hill-Folk of Algeria" (London, 1921), and articles in the *Geographical Journal* (January, 1922) and the *Scottish Geographical Magazine* (July 15, 1922) by M. W. Hilton-Simpson.

With his wife Captain Hilton-Simpson spent the winters 1912–1913, 1913–1914, and 1919–1920 among the villages of the Aures. Here he found a people living just as they had for centuries past in tiny villages perched in rugged mountain nooks which, though no longer a sufficient protection against modern military invasion, still resist the encroachments of modern civilization because they are so difficult of approach. On every side intervene natural barriers. To the north the watershed of the massif, a wall of steep wooded slopes with peaks rising to some 8000 feet, forms a defense which even the Romans found an effective barrier against invasion. Rome seems to have contented herself with protecting the granaries on the plateau. The extent of the ruins of the Roman camp at Lambèse bear witness to the respect with which the Romans regarded these Berber tribes. To the south a wall of bare rocks deeply incised by the southward-flowing streams presents an implacable face to the Sahara. Eastward the bare ridge of the Jebel Shershar running to an altitude of 5870 feet has successfully withstood invasion from nomad tribes inhabiting the country to the east. The western frontier of the massif is equally impassable, its rugged face being pierced by only one deep defile. So impenetrable are these natural ramparts that not until the French invasion of 1845 was the region actually conquered, and even quite recently

bands of outlaws have found an easy shelter in the mountain fastnesses. Islamism has gradually penetrated but by resorting to methods of persuasion instead of force.

It is not surprising, then, that the region is a storehouse of ancient arts, crafts, and customs. Grain is still ground in a twin-stone quern of the type that antiquarians tell us originated in Italy and spread in the wake of the Roman conquest to strangely scattered parts of the earth. Probably Roman too in origin is the water clock used in apportioning irrigation water. Of special interest is the work of the native doctors, their knowledge of materia medica, and their crude yet highly successful surgery, arts which crept into the Aures during the Middle Ages from the Arab practitioners of the time. Far more ancient, however, are many of the arts, that of pottery making, for instance. Several religious ceremonies now practiced as a part of the Islamic ritual also seem to rest on a very ancient basis. Probably more ideas of change and progress have been introduced in the Aures by Shawiya returned from French service during the late war than in the past ages as a whole.

A Great Native Market of the Sudan. The Hausa country of Northern Nigeria is well known as the seat of a commercial activity remarkable in a negroid people, dwelling as the Hausa do far from the sea and "pressed in between the boundless wastes of the Sahara and the well-nigh impenetrable forest of the tropical rain belt." Hausa trade, so widespread that it has given rise to one of the major trading languages of Africa, has always had its center on Kano lying on a great north-to-south trade route. From Tripoli this route runs due south to Bornu (Lake Chad) thence to Kano and southward through bush and forest by divers roads to the Guinea coast. When Hausa trade was at its zenith, in the first half of the last century, the southern terminus was Badagri, near the modern port of Lagos. Trade was conducted by caravan and the great rivers crossed at regular ferries operated by local riverine tribes who levied tolls and guaranteed a certain measure of security in the characteristic manner of this form of trading. Basis of the Hausa trade rested largely on the prime need of the forest people for salt. Salt and also beads and silk from Tripoli were bartered for gold dust, kola nuts, slaves, and European goods from the coast.

Kano itself occupies an exceptionally favorable geographical position, but there are several other important markets in the Sudan, most of them, like Kano, situated about the 12th parallel. This parallel is roughly coincident with the intermediate zone between savana and forest; it separates the oil palms of the latter from the *borassus* and *hyphaene* palms of the former; it marks the southern limit of the date palm. One such important market is Jega which rose into prominence some hundred years ago. It lies southwest of Sokoto on a perennially navigable tributary of the Niger. Three or four days' march away are the productive salt mines of Dallol Fogha on the Dahomey border. Jega also acts as market for the salt of Bilma, southwest of Tibesti, which comes via Agades. It seems worth while quoting a part of Mr. E. W. Bovill's interesting description of Jega market (*Journ. African Soc.*, Vol. 22, 1922, pp. 50–60).

"Although the trade of Jega has been dwindling for some years it still occupies a commercial position second only to that of Kano. Its comparatively small population of about 10,000 includes many rich merchants, mostly natives of Lagos and the Gold Coast. On the outskirts of the town is the large market place comprising over four hundred stalls, built of clay with thatched roofs. Two big markets are held weekly, but there is a fair attendance daily except during the rains, when the trade of the whole country is at a standstill. Outside the town is a *zango*, or caravanserai, of over a hundred houses for traders who pay a small fee for a night's lodging, and here one may see all manner of natives, but they are mostly small Hausa traders. The trade in kola nuts continues to flourish, though on a reduced scale, and a good business is done in European trade goods. By far the most important trade is that with Lagos in cattle. The rapid growth of European and Moslem settlements on the coast has created a big demand for meat. The bulk of this trade passes through Jega and thence southward over the Niger at Gendenne. The following figures for the year 1914–1915 show the magnitude of this trade: cattle 83,592, sheep and goats (mostly sheep) 268,492; horses to the number of 3956 were sold in the market during the same period, while the actual weight of goods brought into the market was estimated at 7556 tons."

The importance in the Sudan and Sahara of the ancient and universal trade in salt is further attested in a short note "Tombouctou métropole du sel" in the September, 1922, number of *L'Afrique Française* (pp. 404–405). The writer describes the fête associated

with the arrival of the great salt caravan. Twice a year the caravan brings the product of the Taodéni mines, mines that have been worked without interruption since the sixteenth century and show no sign of exhaustion. The prosperity of Timbuktu is described as resting almost exclusively on this salt trade, and thereby depends a political situation of interest to the French military authorities—but that is another story.

HUMAN GEOGRAPHY

The World's Coal Markets. One of the most interesting chapters in Professor Fernand Maurette's little book "Les grands marchés des matières premières" (Collection Armand Colin, Paris, 1922) is the first, entitled "Les marchés de la houille."

Among the essential commodities coal occupies first place. A coal shortage makes itself felt not only in the universal use of coal as the most important of combustibles but in the chemical industries, to which coal furnishes a steadily increasing number of by-products, and in the metallurgical industries, where coke is of scarcely less importance in the blast furnace than the metal itself. The yearly consumption of coal steadily grows. From 10 million tons in 1800 the yearly demand had reached 1420 millions in 1913. Previous to the war the coal-marketing countries of the world of primary importance were two—the United Kingdom and Germany; and the markets were the Tyne, the Bristol Channel, and the Ruhr. In view of the enormous and universal consumption of coal this limited number of markets is surprising. Several factors have combined to bring it about. To have an excess of coal is not sufficient. The coal must have certain qualities demanded by the clientele. It must be favorably located with regard to cheap transportation facilities. Sufficient carriers must be at hand to convey the product; and, most important perhaps, the country which furnishes the coal must be able to consume, and the purchasing country to supply, some return commodity.

The United Kingdom, and Germany to a lesser degree before the war at any rate, were able to conform to these demands. The United Kingdom consumed raw material from the whole world and sent her coal to all parts of the earth. In Europe she found it necessary to share this monopoly with Germany; but elsewhere competition was negligible. America, in spite of the fact that her 1913 production of 550 million tons exceeded the total production of the United Kingdom, Germany, and France, was not a rival even in the western hemisphere because her own industries consumed all but 20 million tons of that year's production, and three-fourths of that was anthracite for Canada. Added to this the United States had not begun to develop her facilities for shipping coal abroad. Her coal fields were far from seaports, her means of transportation to the coast limited, her merchant marine a negligible quantity. In 1913, of the coal purchased in the Argentine Republic, only 2 per cent came from the United States while the United Kingdom furnished 98 per cent. Of Brazilian consumption 25 per cent was American coal and the remainder British. The United States stood, therefore, among the secondary coal markets of the world, to which belong Japan, Tonking, and India with their limited local trade; Australia with her trade with the Pacific islands and the west coast of South America; and South Africa, whose trade was also local.

In 1913 Great Britain produced 287 million tons of coal, of which 74.5 millions were exported. Of the exported coal Cardiff, the port of the Welsh fields, furnished 27 million tons; while Newcastle, the port of the Northumbrian field, furnished 24 million—a total of over 68 per cent of the entire exportation. Each of these fields supplied a distinct clientele. Newcastle sent her coal to the Baltic, Russia, Scandinavia, Germany (certain qualities), the Netherlands, and Northern France as far as the Channel. Here commenced the Cardiff zone. To Cardiff and the other Welsh ports belonged the rest of the world—western and central France, Portugal, Spain, the entire Mediterranean, West Africa, South America, and the shores of the Indian Ocean. Germany, whose coal resources in 1913 were estimated at 80 billion tons, possesses like England the advantage of an easy means of transportation by water routes, her principal exporting field lying close to the Rhine. In 1913, 191 million tons were produced, which, together with 10 million of imported British coal, left 45,000,000 for export. The entire Saar output went to Alsace-Lorraine; that of Upper Silesia to the Berlin region; that of Vistula to Poland and Austria. The foreign market depended chiefly upon the Ruhr fields. In 1913 the port of Duisburg exported over 14,000,000 tons, of which about equal amounts went up and down the Rhine. That going downstream went to the Netherlands, Scandinavia, and Russia. The upstream cargoes were for Switzerland, northern Italy, and France, where at Lyons and Paris they met British coal.

Since the war the whole aspect of the world's coal markets has changed. Germany finds her coal fields much curtailed by the treaty of peace, but her loss of territory has also diminished her consumption. It is possible, however, that the Ruhr fields will return eventually to their old place in the world market. England finds her yearly output cut down, in spite of increases in personnel, by the shorter hours and smaller hourly production. Her exportations dropped from 74.5 million tons in 1913 to 38 million in 1920; and of this 92 per cent went to European markets. She no longer supplies the world market that was hers before the war. Increased cost of production—nearly double—and transportation has weakened her ability to compete with local supplies. South African and Australian markets are rapidly becoming more than local. Australian coal has recently sold in Sweden for less than Newcastle coal.

In the meantime, impelled by the necessities of war, the United States has come quickly to the forefront as an exporter of coal. Distance of coal fields from seaports has been largely counterbalanced by efficiency of transportation to seaports and by port facilities. Her merchant marine is more than adequate for some time to come. Her production of coal was 640 million tons in 1920—50 per cent of the world's production. Certain mines specialize in the production of coal for export—some fifteen in Pennsylvania, Maryland, and West Virginia being worked entirely for that purpose. In the Hampton Roads region wharves with the most efficient of loading equipment, adopted from the Great Lakes ports, have been built. American coal is still to be found in Mediterranean markets but in steadily decreasing amounts. The export field for American coal probably does not lie in Europe; but a great field is open in South America and the Pacific where ships can find much raw material with which to fill their holds on the return voyage. Argentine consumption of American coal increased from 2 per cent to 46.2 per cent from 1913 to 1917 with a slight decrease since. Brazil used 78 per cent of American coal in 1917 against 25 per cent in 1913. The great coal marts of the world are no longer confined to the Tyne, the Bristol Channel, and the Ruhr. To them has been added Hampton Roads.

HISTORY OF GEOGRAPHY

Physical Geography at the Court of the Emperor Frederick II. The Sicilian Court of that original genius, the Emperor Frederick II (1212–1250 A. D.), was one of the rare spots where during the Christian Middle Ages a genuine interest in science was fostered. Frederick used what we now believe to be essentially modern methods of research—observation, experiment, and the questionnaire. Professor C. H. Haskins in an important article on "Science at the Court of the Emperor Frederick II" (*Amer. Hist. Rev.*, Vol. 27, 1922, pp. 669–694; reference on p. 688) tells us that "Frederick, not long before 1242, sent a series of questions to be answered by Mohammedan philosophers in Egypt, Syria, Irak, Asia Minor, and Yemen, and later to the Almohad caliph of Morocco, ar-Rashid." The text of another of these questionnaires, in which the Emperor propounded to his court astrologer, Michael Scot, some searching inquiries into matters of cosmology and physical geography, has recently been published in another article by Professor Haskins (C. H. Haskins: Michael Scot and Frederick II, *Isis*, Vol. 4, 1921, pp. 250–275, Brussels. A translation of the questionnaire will be found in Professor Haskins's article first cited, pp. 689–691). Frederick craved to learn many things: the location of the abyss, of hell, of purgatory, of paradise; why the sea is salt; and the causes of hot springs, volcanoes, and other natural phenomena. It is interesting to note that in the midst of his doubts and perplexities, of one fact Frederick was sure. "For we greatly wonder at these things," he says, "knowing already that all waters come from the sea and passing through divers lands and cavities return to the sea, which is the bed and receptacle of all running waters." Michael Scot's reply contains much typical geographical lore of the Middle Ages. Particularly noteworthy is the description of the hot springs, volcanoes, and sulphur beds of Italy, Sicily, and the Lipari Isles, the text of which is given by Professor Haskins (*Isis, loc. cit.*, pp. 272–274). If Michael's "knowledge of the Lipari group does not necessarily rest on personal observation, it at least represents inquiry among those who have observed. Although the omission of any special account of Etna is noteworthy, he has in these local matters gone well beyond Aristotle's *Meteorology* [the source of most of the meteorology, vulcanology, and seismology of the Middle Ages] and given some real description of volcanic phenomena." Michael mentions especially "Strongulus" (Stromboli), "Strongulinus" (Strombolicchio?), "Vulcanus" (Vulcano), "Vulcaninus" (Vulcanello?), "Moncibellus" (Etna), and "insula Lipari" (the island of Lipari), "in which are all kinds of

fine trees and grains." Stromboli, he says, is a great mountain in the midst of the sea, which constantly emits flames. Flames also spring from Vulcano, Vulcanello, Etna, and the island of Lipari, but only when the south wind (*auster*) blows. When the flames cease, mighty smoke pours forth. Michael's detailed comments on the volcanic *ejecta*, the pumice strewn far and wide over the surface of the sea, and on the manner in which it is gathered by the people for use as a building material, and finally on the manner of obtaining sulphur from the sea's surface—all reveal more than book knowledge of these regions. In his discussion of the causes of vulcanism and of thermal springs, on the other hand, Michael confusedly follows and enlarges upon classical models. Briefly stated, he believed that these phenomena are due to wind penetrating into the cavities of the earth and there coming in contact with sulphur and other burning stones (*petrae calidissimae*). A great mercy of God it is, he adds, that this sulphur and these stones are hidden away far beneath the surface, for otherwise the winds blowing over them would destroy the world with their heat.

GEOGRAPHICAL NEWS

Obituary

Henry Vignaud. Henry Vignaud died at his home in Bagneux, Seine, France, September 18, having all but reached his ninety-second birthday.

Among the keenly critical students of early New World discoveries Mr. Vignaud held preëminently the leadership, being justly entitled to be called, in his last years, "The Prince of Americanists," which term he had once graciously employed to characterize his long time friend Mr. Henry Harrisse, but a friend with whose conclusions he did not at all times agree.

His had been an exceedingly active and useful life. To his native state, Louisiana, he was a loyal son, first attracting attention to himself as a newspaper correspondent and editor and, in the earlier months of the Civil War, as Captain of a Louisiana Regiment. His abilities brought to him an appointment as Secretary of the Confederate Diplomatic Commission to Paris in the year 1863, and practically all the remaining years of his life were spent in Europe, with but occasional interruptions, at Paris. In the Diplomatic Service of his country after the war was over he achieved very notable distinction, serving at times as a member of commissions and of important conferences, being appointed in the year 1875 Secretary of the American Legation in France, an office he filled most acceptably for thirty-four years. In 1909 he was retired but continued to hold until his death the title Honorary Counsellor of the Legation. The last two decades of his life were by far his most fruitful within the literary field, in which years he won for himself a very enviable international reputation. The list of his publications is a long one—books, pamphlets, articles for the more prominent periodicals representing the field in which he was so greatly interested, especially for the Journal of the Société des Américanistes, which Society he served many years as president.

Mr. Vignaud was a keen critic who delved deeply into the contemporary records of the period which claimed his interest, and not a few of the long accepted but not well authenticated beliefs concerning Christopher Columbus he so successfully attacked as to warrant the emphatic statement that the older biographies of the admiral must either be discarded or rewritten.

It is but the briefest reference to his position that can here be made. Let it be noted that a very respectful hearing was accorded him for his first important work, "Toscanelli and Columbus," wherein he contended, with arguments most elaborately supported, that there never was a Toscanelli letter nor a Toscanelli map such as practically all Columbus' biographers have been inclined to accept. In a letter to the author of this brief note which was received but shortly before his death he expressed himself as not feeling inclined to give further consideration to the Toscanelli question, since we now know so well the purposes and plans of Columbus before he sailed. These did not include a search for a westward route to the Indies, but as is so clearly set down in the Capitulations signed by the Queen, the King, and Columbus himself on the eve of his departure, it was to find "islands and mainland"; and these he found, the greater glory being his for so doing. It stands to Mr. Vignaud's credit to have found in contemporary documents convincing testimony that Christopher Columbus was not born in the year 1436 nor in 1441 but in 1451; that he was never a student at the university of Pavia; that there was no other distinguished admiral in his family; that his so-called scientific theories were formulated after his discovery of the

year 1492 and not before; that we have a decidedly prejudiced account of his life in the biography attributed to his son Ferdinand and in the biographical record left by Las Casas.

Among Vignaud's more exhaustive studies, in addition to his "Toscanelli and Columbus," we have his "Histoire critique de la grande entreprise de Christophe Colomb" in two sumptuous volumes, and his "Américi Vespuce." During the last years of his life he was engaged in the preparation of a work of considerable magnitude which he called "Les sources cartographiques imprimées de l'histoire de la géographie." He worked with the enthusiasm of youth to the last "with a clear vision," as he said, but with a frequently expressed doubt that he would be spared to complete the task he had set himself. This work he left in manuscript.

E. L. STEVENSON

NOTE

M. le Commandant Ch. Gorceix has called the writer's attention to an error in his note on the Abyss of Cap-Breton in the July, 1922, number of the *Geographical Review* (p. 501). M. Gorceix regards the abyss as probably the result of solution of gypsum or rock salt, but the idea that the solution has been accomplished by "a subterranean river" was only quoted from other sources and not adopted by him.

W. M. DAVIS

GEOGRAPHICAL REVIEWS

On Human Geography

P. Vidal de la Blache. **Principes de géographie humaine publiés d'après les manuscrits de l'auteur par Emmanuel de Martonne.** vii and 327 pp.; maps, indexes. Librairie Armand Colin, Paris, 1922. 25 fr. 10 x 6¾ inches.

Paul Vidal de la Blache died in 1918. At the time of his death several of the chapters of this work had appeared in the *Annales de Géographie* for 1917 and 1918; but the greater part was still in manuscript and some of it in fragments. The preparation of the whole for publication in book form fell to M. de Martonne of the Sorbonne, Vidal's former pupil and one of his successors. M. de Martonne explains in the preface that Vidal would have been far from satisfied with the work as it stands, unfinished. Publication, none the less, was eminently worth while. In spite of incompleteness and imperfections, "Principes de géographie humaine" expresses the fully matured thought of one who for many years was the leader and inspiration of that French school which is doing more, perhaps, than any other group to establish human geography upon a sound and scientific footing.

Human geography, as Vidal interprets it in his short introduction on the "meaning and purpose of human geography," goes far beyond mere objective description of countries and peoples. It grows from "a new conception of the relations between the earth and man, a conception suggested by a more synthetic understanding of the physical laws which govern our terrestrial sphere and of the living beings which inhabit it." Underlain by the notion of the unity of nature and of the interlocking connections of terrestrial phenomena, its purpose is to reveal man's relation to that complex of inorganic and organic elements which in any given area constitute environment and to determine, but never to exaggerate, the influences of environment on men "which do not show except through the veil of historical contingencies." Human geography owes its very existence to advances that have been made during recent years in the natural and human sciences. An especial debt does it owe to ethnography and primitive archeology, for primitive folk are more directly and obviously seen in relation to their environment than peoples of higher development. Not less is its debt to progress in our knowledge of the fundamental facts of the distribution, density, and composition of population. Human geography must take cognizance not only of man as passively adapting himself to environmental influences but also and even more emphatically of man as a "geographical factor" himself, capable of exerting profound modifications upon the face of an ever changing earth.

The main body of the book is divided into three parts, each of which is a unit in itself. Part I, devoted to the distribution of population over the globe, includes the chapters which appeared in the *Annales de Géographie* and was summarized in some detail in the *Geographical Review*, Vol. 7, 1919, pp. 52–53.

Part II, on "forms of civilization," is the most original portion of the book and bears most clearly upon it the stamp of the writer's genius for close reasoning and precise generalization. Here are analyzed the relations between the geographical factor in man's environment and various products of human activity: material and tangible objects, such as tools, clothing, arms, building materials, villages, cities; intangible concepts, such as the evolution of civilization and progress.

To illustrate Vidal's treatment of the material side we may refer to the discussion of "établissements humains." As used by the French geographers, this phrase, for which we have no precisely corresponding term in English, denotes those structures built by man to house himself and his property. They may be either for permanent or for temporary occupation and either isolated or in groups, whether tents, huts, cottages, houses, barns, factories, storehouses, or farms, hamlets, villages, towns, metropolitan agglomerations.

The problem of sites is one of immense complexity, especially where settlement has been long established, as in Europe. Historical causes and the intricate conditions of human occupation there have often completely modified and obscured the effects of natural in-

fluences. A general rule, nevertheless, may be formulated: that "human establishments" show a tendency to spring up at points where access is most easily available at one and the same time to the greatest possible number of elements, such as water, soils, pasturage, woodland, vineyards, etc. These points are frequently found along the well defined lines of contact of different geological formations, a circumstance which explains the phenomenon of "villages in series" common in some parts of Europe. The influence of commercial routes is far less potent, and the rural community of Europe as often as not centers around villages standing apart from the highways.

The grouping of rural habitations is characterized either by dispersal or agglomeration. The dispersed habitat is found where there is pronounced diffusion of waters and where there is diversity in the orientation of slopes and in the nature of soils over limited areas. Brittany with variegated surface pattern and scattered hamlets and dwellings is a typical region of dispersal. Dispersal also usually prevails among mountains. The agglomerated habitat—in other words the compact village—is not only found along the lines of contact of geological formations or of other features of the terrain but also is eminently characteristic of broad plains of uniform soil and relief, where economy is attained through cultivation on a large scale together with the centralization of labor, tools, water, granaries, and all that is incidental to the exploitation of the fields. The agglomerated village occurs in many parts of Europe but is preëminently typical of the plains of China and of India.

Vidal de la Blache makes some striking comparisons between the position held by the village organism in relation to society as a whole in India and China on the one hand and in Europe and America on the other. The village of the Far East is the essential social unit, "absorbing a strong part of the social life to the detriment of the vaster organizations of the city or state." In Europe under modern industrial conditions this is no longer so: the influence of the city over rural life is becoming ever more powerful. In America, Vidal asserts, urban influence is supreme; the village stage of social development has been virtually skipped, and, except in the older parts of the country, the village essentially does not exist at all. "The actual means of circulation, the creation of *entrepôts* provided with all kinds of merchandise and the custom of transforming agricultural products into bank credits, take away from the village much of its *raison d'être*. It is to the city, even to the very large city, that rural groups turn. The city controls the relations between rural peoples."

After passing in review the material products of human activity in their geographical relations, Vidal undertakes the more ambitious task of explaining the geographic elements in the evolution of civilization and of progress.

There are two opposing tendencies in mankind, he says. One of these is "a natural tendency toward perfection." Revealing itself even among the most primitive folk this is a force of will, a creative and artistic impulse that urges man to exert ingenuity and skill, to make himself the master of his surroundings and of the materials with which he works. If all progress springs from this impulse, it is ever opposed by the second tendency, the tendency toward stagnation due in part to natural indolence and in part to the erection of artificial prejudices against all that is new. In some regions the first of these tendencies has prevailed, and development has been more or less continuous. Elsewhere, after reaching a certain point, development has been arrested, and life has become stereotyped, governed by archaic forms and customs. Vidal de la Blache seeks for a geographical explanation of the reasons why some regions have favored progress.

If we interpret his meaning rightly, progress springs largely from the interchange of ideas and customs; where geographical conditions have encouraged a maximum of such interchange and intercommunication, progress has been most rapid. Isolation and stagnation are almost synonymous. But mere contact between two civilizations, one static and one advancing, rarely is capable of producing any radical alteration in the life of either. Invasion has seldom greatly modified the habits of the conquered, and China and India have shown themselves proof against fundamental changes brought through the extension to their shores of the maritime commerce of the Western nations. Japan's absorption of Occidental manners is superficial rather than fundamental.

Strong civilizations, Vidal believes, grow from the merging and amalgamation of many previous civilizations. The Mediterranean culture of the Roman Empire was built from a combination of Greek, Etruscan, Phoenician, and other elements; and each of these from a series of earlier combinations. If the origins of civilizations be sought for, they will be found in diverse nodal points; and the more numerous and variegated these be, the richer and more progressive the civilization arisen from them. The geographical features of the

Mediterranean basin and of Europe have been more favorable than any other part of the world to such progress. "Neither the great river valleys deep in alluvial soil, nor the living waters of the Mediterranean, nor the rich plains of the Danube or of southern Russia suffice by themselves alone to explain the persistence under divers forms of progressive civilizations. But the distribution of seas and lands, the interspersal of plains and mountains, the contiguity of steppes and forests have made it possible for geographic causes here better than elsewhere to combine in their effects. . . . European civilization has been nourished in its origins at a multitude of distinct hearthsides, has absorbed the substance of a large number of local *milieux*. From these antecedents, from this elaboration that has progressed through centuries, mutual connections have been actively maintained, and European civilization has drawn its richness and its fecundity."

The third part of "Principes de géographie humaine" is devoted to the analysis of an aspect of human enterprise which lends itself readily to geographical treatment: circulation and transportation. One cannot fail to detect a difference in character between this portion of the book and the preceding parts: the treatment is more descriptive and empirical, the thought less close, the scope of ideas less ambitiously framed, and the generalizations perhaps a shade less penetrating. Possibly this arises from the more obvious nature of the subject, but we believe rather that it was due to the intervention of death before Vidal could bring this part of the work to the fully matured stage of development attained in the earlier parts. In Part III we are led in logical order from the survey of the geographical relations of the simplest and most archaic modes and routes of transport and circulation to that of the most complex and highly organized, from the consideration of man himself as a beast of burden to that of the railway and steamship. Striking observations are made in regard to the influence of railways on the opening up of hitherto undeveloped regions—the Middle West, Canada, Argentina, Australia, New Zealand, to the changes in the distribution and density of population that have resulted therefrom, and to the immense influences of maritime navigation. The idea is constantly kept before us of the development of transport as an active geographical factor, as a force which has tended ever to mold anew the human geography not only of regions and of continents but in later years of the entire world.

No longer do we try to explain the infinitely complex story of mankind in simple terms. Leadership or social conflict, religion or the quest for food, intellectual force or environment—no one of these is sufficient. If some of the details of historical events lend themselves to proof, the interpretation of these details, the very soul of history, assuredly does not. Here all that gives us confidence in a man's work are openmindedness, the power of wise and fair selection, and that sublimated common sense sometimes known as the critical spirit. Vidal de la Blache's great contribution to human geography was to bring to it these qualities of historical mindedness and to show that they are the essentials of geographical mindedness as well. Their lack among its devotees has been one of the obstacles to the development of human geography. This is what Lucien Febvre in his "La terre et l'évolution humaine," reviewed below, constantly brings up against Ratzel and his disciples. In their enthusiasm to explain the influences of environment they have been blinded to the recognition of all other influences. Vidal de la Blache is one of the few geographers to whose work Febvre gives well-nigh unstinted praise.

It is enlightening to compare the two books of Febvre and of Vidal, which happened to appear at about the same time. Both show great erudition, both are keenly critical, both warn against the evils of generalization built upon insufficient facts or upon the faulty interpretation of too abundant facts. Where Febvre directly and aggressively pulls to shreds the arguments and assumptions of Ratzel and others with whom he disagrees, Vidal accomplishes the same thing by more subtle and less pugnacious means, setting forth the positive and constructive results of his own research and thought. Where Febvre oppresses with a stifling sense of the difficulties and dangers that beset the man who dares to venture upon the quicksands of human geography, Vidal with the pen of a genuine artist stimulates the reader to follow him in the study of a difficult but alluring subject. Where Febvre, without expressly denying that it exists, leads us to despair ever of finding the geographical element and its influence upon human life, Vidal with sure and delicate touch unweaves what is geographical from the tangled skein of other influences. If Febvre's book is admirable as a corrective to looseness and hastiness of thought, Vidal's is all of this and much more besides—a great, constructive, and permanent contribution to science and to literature.

LUCIEN FEBVRE. **La terre et l'évolution humaine: Introduction géographique à l'histoire.** xxvi and 471 pp.; maps, bibliogr., index. (L'Évolution de l'Humanité, Vol. 4.) La Renaissance du Livre, Paris, 1922. 15 fr. 8 x 5½ inches.

A geographic introduction to history ought to help one to read history. This is rather a warning that geography has not yet much that is sound to offer and that a great amount offered is unsound. "In reality we only know trifling details of the influence of geographic environment on human societies: the geography which should describe that influence is barely beginning to be born and established." Ratzel's work is too ambitious in the assumption that his erudition suffices for the examination of the world; but, vast as was Ratzel's erudition, it did not begin to meet the need. We need years and years of patient studies of limited regions such as a good many Germans and a small group of Frenchmen, under the inspiration of Vidal de la Blache, have been making, to prepare a suitable body of observed facts on which to generalize. Perhaps it is natural that Febvre should overemphasize the work of his countrymen. Ratzel's concept of the essential vitality of a state in its "desire, hope, and constant appetite for expansion" is fairly criticized as not geographic but German.

Good service is done in demanding critical thought. It is not worth while to describe landscapes and climates in the first chapter of a history and then never revert to the subject again as Duruy and Curtius have done in writing histories of Rome and Greece. To offer to tell what a people is like if told what their environment is, as Michelet has done, is mere rhetoric. It is futile to hope for enlightenment from vague generalizations about Man, Nature, and Influence. That is the fault here found with Ratzel and his disciples, especially Miss Semple. I might interject that precisely the unsound, or unbased and inaccurate, generalizations of which the apostles of Projects in Geography are most fond, are anathema to Febvre. "'Hunting and fishing,' writes Montesquieu in Chapter IX (Du terrain de l'Amérique), increase men's stores to plenty.' They complete thus the work of 'nature, which produces spontaneously many a fruit for man's nourishment.' " Febvre comments: "Simple ideas, simple actions, unprecise generalities" (p. 110). Perhaps a reader well versed in geographic influences will wonder what he would have Montesquieu say. Were there not abundant natural fruits, and did not hunting and fishing add most acceptably to the resources of the American pioneers? That, Febvre seems to think, depends on the men! Nature nourishes and especially gives liquid to satisfy thirst to Australian blacks in the same environment where she lets a European die of thirst. Stefansson ("The Friendly Arctic," p. 323) tells us game is abundant and easily available on the spot where Sir John Franklin and his men starved [my illustrations]. Nature limits herself strictly to offering opportunity. She nourishes no one. She makes no one do anything; she gives men a chance. Men, according to their habits, overlook the chance or accept it in full or in part. We should follow Vidal de la Blache in studying *the relations between actual human societies and their environment.* This Febvre contrasts with Influence of Nature, in capital letters. That is the keynote of the book if it has one. Nature exerts no influences at all! Also Febvre wants to bring out here the neglected action of man on nature.

Miss Semple, he says (p. 205), expresses "with enthusiastic faith" the views he combats. She cites the narrow negro-inhabited region south of the Sahara as of little variety of relief or climate and of monotonous development, rudimentary agriculture and lowest forms of pastoral life making it a unit region in its monotony. "Do not object that the picture is too crude; that it rests on a very superficial knowledge of the physical and human geography of a country which the explorers, more and more, are representing as extremely varied in its productions, extremely rich in its possibilities, all made up of regions quite differentiated, and all peopled by a veritable marquetry of tribes of utterly different origin. Do not object, for it is useless making objections to a believer armed with a dogma that may not be discussed."

Of course Febvre pays his respects to the time-honored doctrine that humanity has passed through three stages of culture: the hunting and fishing stage, the grazing-nomadic stage, and the agricultural stage. Wasn't that a regular and normal succession, in all probability? Haven't all peoples come through the three in that order? These were culture stages, too; of savage hunters, semicivilized nomads, and civilized agriculturists! Febvre thinks Mortillet in 1890 the last serious observer to be convinced of this old theory. Its defects began to be evident thirty years ago. For observations of fact were multiplied, and it became evident that it was hard to find "pure" stages. Actual peoples, wherever observed, have done more or less all of these things at the same time. Other stages, too, are proposed by ob-

servers, for such peoples as collect fruits and roots and have no tools and fall into none of the three classes. It has become clear that there is no necessary passage between stages in the traditional order and that links may be missing in the chain, as in Mexico and Peru, where the agricultural people of pre-Conquest days had never been pastoral. It is clear that two of these distinct stages do coexist today in one people at the same time, as when a fisher Indian has a wife who collects berries and roots. Roscher pointed out in 1903 that either hunting or grazing or agriculture may be the earliest stage, according to accidents of place or climate. Nowacki in 1885 undertook to prove that the first tillers of the soil had no animals and used only a hoe, coming later to acquire horse and cow without passing through a nomad stage at all. Hahn in 1896 (Edward Hahn: Demeter und Baubo. Versuch einer Theorie der Entstehung unseres Ackerbaus, Lübeck, 1897) proposed the scheme: (1) use of the hoe in agriculture (millet-raising among the lake dwellers); (2) taming of the ox, first as a sacred animal, later for use; (3) use of cattle and horses and nomad life; (4) invention of the wagon—first sacred, drawn by the sacred ox; then the plow drawn by the ox for use; (5) modern type of agriculture. However satisfactory or unsatisfactory this may be, it is good procedure as an attempt to meet actual facts of observation. It is not authoritative, but improvable where reason can be shown. Furthermore, careful observations do not show nomads to be inferior to agriculturists, nor the other inferiorities demanded by the old theory. The stages discussed were stages of food-getting, not stages of culture. Culture was mere assumption, like the time order of the stages themselves. As a matter of fact it appears more probable that habits are the *cause* of the method of food-getting adopted by a people than a result of the way nature thrusts food upon them! A remarkable case is that of the pygmy hunters living permanently alongside the agricultural negroes of central Africa (p. 302); the pygmies raising no vegetable crop, the negroes hunting no game but exchanging their vegetables with the pygmies for meat. Yet the two peoples live side by side in the same environment, their villages intermingling. Habit, not environment, gives each its occupation.

Of course Febvre is fallible. He thinks an arrow would hardly kill game, unless poisoned. The North American Indians certainly killed the bison with bow and arrow: or is that another myth?

There is much that is suggestive in the criticism of theories of culture stages. The Arab, supposed to draw from his desert home the imagination that inspired the Koran, is accused of borrowing the plan of the Koran from the Jews. Never in historic time, says Febvre, have any nomads been able to support themselves by their flocks alone. Always their main food has been grain, which they obtained from their sedentary neighbors. The nomad is merely the wanderer—the word Kirghiz, for instance, is said to mean only that—the man driven away from the good land, the agricultural land, by his enemies whom he therefore hates and envies for their possessions.

Enough has been said to give an idea of the book. The author has read much, especially French writings, and has tried to criticize. His style is somewhat confusing; he resorts to veiled irony that, to the English reader, is not always clear. If he wished to help geographers, he would have done better to have selected from all he has read that which he regards as sound. Probably this would have contained a great deal of material drawn from Vidal de la Blache.

MARK JEFFERSON

HIGH ALTITUDE POPULATION DISTRIBUTION IN SWITZERLAND

H. DE MONTBAS. **Le peuplement des Alpes Suisses: Sa répartition et ses limites d'altitude.** Map. *Mémoires Soc. Fribourgeoise des Sci. Nat.*, Vol. 8, 1919, pp. 155–240.

The two main questions considered in this discussion are: "What is actually the distribution of the inhabited centers of the high mountains in the Swiss Alps?" and, "What conditions formerly determined their creation and still govern today the development or decadence of these centers?"

The author first takes up the study which presents the actual distribution in Switzerland of the inhabited places situated at or above an altitude of 1000 meters—a contour line corresponding to a well-defined geographic and climatic unit—and then passes on to the discussion of the most characteristic cantons from this viewpoint.

The population density of the Alpine zone per square kilometer is scanty and unequally distributed. The census of 1900 shows 315 communes whose principal agglomeration is

found at an altitude of over 1000 meters. These represent about one-tenth of the total of Swiss communes, but their territorial extent includes more than one-half of the surface of the country. These 315 communes have a total population of about 200,000, a little more than five per cent of the Swiss population.

Among the Alpine cantons (Grisons, Valais, Bern) having the largest number of inhabitants above 1000 meters, the Grisons holds first place. Its area is 7113 square kilometers, of which 3500 are given over to agriculture and 1438 to forests. 30.5 per cent of the total is unproductive, showing the presence of high massifs and glaciers. The population has increased more than ten per cent between 1900 and 1910. The average density is 15 inhabitants per square kilometer, or 25 per productive area. Of the total population 54 per cent lives above 1000 meters; of which 14 per cent lives between 1500 and 1800 meters and 4 per cent above 1800 meters. In no other place in Switzerland or even Europe, except a few in Valais, do we find centers of permanent habitation as high (reaching 2100 meters in Avers). Temporary huts or settlements are found on the highest snow limits; pastures are generally found at 2400–2500 meters and sometimes, for sheep only, at 2700 meters.

It is because these high mountains are accessible that we see villages forming at an altitude of 1500 meters or more. It is because they are generally poor and barren that the inhabitant has to resign himself to live on little, to substitute for an intensive and remunerative culture an extensive exploitation of land merely for pasturage.

Climate, precipitation, floods, hostile neighbors, and human caprice are some of the factors that enter into the establishment of settlements. The creation of artificial centers, such as inns and hotels, and the development of roads and railways add still more to the development of the heights. It is these last factors that have contributed most largely to a considerable increase of population in many mountain communes, notably in canton Grisons.

A number of tables showing heights, the increase and decrease of population, and the communes in Switzerland above 1000 meters are found throughout the article. A relief map (1 : 600,000) shows the distribution of the inhabited centers in the Alpine mountain cantons above the 1000-meter line. It indicates the highest pasturages, the principal passes and roads, and the places that have had a notable increase between 1900 and 1910.

HÉLÈNE NEUMANN

A Popular History of the Roads of France

JEAN BONNEROT. **Les routes de France.** iv and 167 pp.; maps, ills. Les Évocations Françaises, H. Laurens, Paris, 1921. 10 x 7 inches.

This book, with its many and attractive illustrations, is a popular history of the roads of France and of their relation to the life and development of the French nation. It is a very flowery book indeed, full of brilliant color and Gallic rhetoric. Its avowedly popular and rhapsodic character may explain, but does not altogether justify, a tendency toward sweeping generalization. It is obvious that routes have an important influence in determining the sites of battlefields, but it is misleading to state, as the writer does on page 72, that "La France est peut-être le seul pays où la route ait toujours determiné l'histoire et marqué par avance les lieux de ses victoires et de ses défaites." M. Bonnerot often seems to get the cart before the horse by attributing to the roads the power of bringing about political, social, and other effects which in reality merely find their reflection in the highways. Figures of speech, perhaps; but figures of speech are often treacherous.

The book, none the less, is a worthy contribution to the literature of travel as a form of human enterprise (see *Geogr. Rev.*, Vol. 11, p. 628), not only from the stylistic point of view but because we find in it a fresh grouping of facts. There is distinct geographical value in a broad sketch of the history of travel and communication of a European region from the days of paths hacked through the forest by the stone axes of cave man and lacustrine dweller to this present age of railroads and automobiles.

During epochs of strong and stable government the routes of France were well kept up, and communication generally was easy and uninterrupted. The Roman roads, built in the main for political and military purposes, with their massive structure and undeviating course across country, were symbols of Roman rule and fell into disrepair and disuse only when the Middle Ages brought about the political and social shattering of the country.

In the medieval period far poorer roads took the place of the Roman highways, but these were enlivened by new types of wanderers: crusaders bound to the Holy Land, pilgrims to the shrine of St. James of Compostella, merchants to the fairs of Champagne or Flanders. The turbulence of the Hundred Years' War and Wars of Religion made itself felt in insecurity of life and desperate difficulties of travel, but as the nation gradually emerged, a strong and unified monarchy at the close of the sixteenth century, the administration of the main lines of communication was taken over by the crown. Sully, the great minister of Henry IV, was made "Grand Voyer de France;" Richelieu instituted the public post; Colbert undertook road building on an immense scale with the aid of the *corvée*, or obligatory employment of peasant labor. The Corps of Bridges and Roads, organized in 1713–1716, was the main factor in building and improving that great network of highways, successor of the Roman network, which is the pride of modern France. M. Bonnerot's portrayal of life on the royal roads and of travel by diligence is the most lively and entertaining part of his book. The abandonment of the roadways which resulted from the building of railways was temporary. With the age of motor transport the great highways of France have once more come into their own. Heroic was the part they played in the World War. Indeed a new era of highway construction is now opening with the building of tourist automobile routes through the Alps, along the Riviera, and in the Pyrenees.

Economic Psychology of the Spaniard

Alfred Rühl. **Die Wirtschaftspsychologie des Spaniers.** *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1922, No. 3–4, pp. 81–115.

With this short paper Dr. Rühl has opened a new field of the utmost importance to geography, the economic *ethos*, or standard of a nation. The paper is most illuminating. A certain complication comes in, however, for an American reader, since not merely its language is German, but the author's economic ethos too is German. Hence the picture of Spanish feeling in economic matters is obscured by a veil of German feeling. For example take the author's comments on the admirable inner democracy of Spain, the complete lack of real caste spirit: "In the street railway a high officer chats the whole trip with a workman sitting beside him." "House steps that were only for masters (Herrschaften) would be quite unintelligible to Spaniards." The American feeling in these matters is certainly not that of the German and probably not quite that of the Spaniard.

In general many good observers through a number of centuries have found the Spaniard to be intensely miserable. Setting aside the past here are a few touches of the present: "More than half the people can neither read nor write. Almost nothing is known to them of other countries. They are behind the world in agriculture and industry. They get no proper returns from the soil, no fair share in the wealth that foreigners take out of the country. Though the winters are usually cold, they have no means of warming their houses. In all the central and north-central part of the land a bed is a luxury. Most of the country people sleep in their barns, if they have them, on the straw, with all their clothes on, covering themselves for a blanket with what serves them as cloak by day. Their clothes are never taken off until discarded because they can be mended no more. Wages are 30 to 40 cents a day except in harvest time, when they may rise to $1.40. Their food is bread, a little of some vegetable, olive oil, and salt fish. Meat is hardly used."

There has been no strenuous industry in Spain since the days of the Moors except among the Basques and Catalans of the north and northeast. When the Moors and the Jews were driven out, Spain lost the men who had given her agriculture, irrigation, and industry; who had brought her the orange, the date, the pomegranate, the almond, sugar cane, cotton, and silkworms; who had planted olive groves and exploited mines; who had inaugurated manufactures that had made Spain significant and famous in world trade. When these men departed no Spaniards took their places, and their work simply ceased to be done.

The keynote of the Spaniard's economic feeling appears to be that he does not regard strenuous exertion as tolerable at any price whatever. Work is rather disgraceful in any case, but very hard work is not to be thought of at all. He has no regret in doing without the things that strenuous work might bring him. Extreme sobriety and moderation are his substitutes for progress. "Don Quixote's advice to Sancho Panza—eat little for dinner and less for supper—is national practice." Measured by the customary standards Spain

is backward in almost everything. The Spaniards draw from their land nothing like the wealth that Germans or Englishmen would. They make few things as well as foreigners. Even their own special products they elaborate badly or leave to foreigners to elaborate. They have poor communication and little commerce. They thought Spain a great power until the United States took their colonies away from them. In fact most of their shortcomings are unknown to them.

This is the most interesting aspect of their case and one that Dr. Rühl does not set forth explicitly. The Spaniards are *not aware of their wretchedness*. They think their country a paradise. Apparently nothing can be done for them until they have been shown how miserable is their lot! Such missionary work would be of course well worth while to anyone who can supply the needs he awakens in them!

Furthermore, it is interesting to note how lightly the alarms of the Malthusians pass over the heads of this people. Dr. Pearl showed in the October *Review* that we progressive nations are consuming the world's resources at an intolerable rate. Not so the Spaniard. If he could only get his progressive foreigners out of his country his resources would supply his moderate needs for many another century!

MARK JEFFERSON

THE SEA IN THE HISTORY OF JAPAN

G. A. BALLARD. **The Influence of the Sea on the Political History of Japan.** xix and 311 pp.; maps, diagrs., index. John Murray, London, 1921. 18s. 9 x 6 inches.

As Admiral Ballard states in his Preface, the purpose of this work is "to extract [from the different histories of Japan] all matters of political importance on which the maritime situation has produced an effect, and add the comments suggesting themselves to a naval officer." For the adequate fulfillment of such a task, the author's high professional standing and his many years spent in Far Eastern waters qualify him in an altogether exceptional degree; while the fact of his birth in India may account in a measure for that sympathetic comprehension of things Oriental which he displays throughout.

The Introductory Chapter is devoted first to an analysis of the effect of the late war upon Japan's place in the world and then to a brief résumé of her political development and her relations with other nations down to the period following the war with Russia.

Chapters I and II treat of the period up to the close of the sixteenth century. The account of the gigantic efforts of the Mongols to conquer Japan, in the last quarter of the thirteenth century, is especially praiseworthy and could only have been written by a practical seaman. The story of the Japanese invasion of Korea, three centuries later, also well told, brings out most clearly the decisive part played in that struggle by the control of the sea. Doubtless to many readers it will come as a surprise that the Koreans then produced an admiral who, alone of all the world's great sea fighters, can claim a place beside the victor of Trafalgar; the account of Admiral Yi-sun's operations and the effect they produced upon the outcome of the war as well as upon the entire subsequent history of the Far East, is one of the best portions of the book.

The two following chapters carry the narrative through the period of seclusion, down to the opening of the country, with the accompanying disturbances and outbreaks against the intruding foreigners; while chapters V and VI have to do with the Chino-Japanese War and the first alliance with Great Britain. The author shows the vital importance of Korea to Japan and the manner in which that peninsula has had so often to suffer because of its location between two great empires; while due credit is given to the now nearly forgotten efforts put forth by Japan, throughout the last quarter of the nineteenth century, toward the strengthening and upbuilding of Korea to form a really effective independent buffer state. But the reader's attention is of course mainly directed to the maritime aspects of the war, the description of the naval battle of the Yalu in this connection being probably the best account of that combat that has appeared in English. This part of the book makes particularly interesting reading in view of the precisely similar ways in which the geographical factors made their influence felt just a decade later, in the course of the Russo-Japanese War.

Chapters VII–IX deal with the Russo-Japanese War as influenced by the operations at sea. Its causes are discussed at some length, and the geographical setting is described, the fact being pointed out that in this respect all the advantage lay with the Russians save in the one particular of nearness to the theater of war. Attention is given to the movements of the

Japanese armies; and the various naval actions, particularly that known as the Battle of the Yellow Sea, whereby the Russian sea forces in the Far East were placed practically *hors de combat*, are graphically described. There follows the account of the later phases of the struggle, including the fall of Port Arthur and the long voyage of the Russian Baltic Fleet to its complete annihilation at Tsushima, with, finally, a clear and lucid discussion of the conclusions to be drawn from a study of the special features of the war.

The Conclusion, of nine pages only, treats of the results of the Russian War to Japan, the significance of her victory in connection with the development of the Far East, and her situation as regards the possibilities of a defensive war against any other Power.

The two appendixes have to do with the relative strengths of the Japanese navy and those of her opponents in the Chinese and the Russian wars respectively, and their interest is naturally mainly a technical one.

In a sense Admiral Ballard may be said to have anticipated the results of the Disarmament Conference held at Washington last winter; for he displays comparatively little faith in the efficacy of the big ship as an instrument of sea power, pointing out that Japan, with a couple of hundred submarines, could render it practically impossible for any foreign battle squadron to approach her shores or even to enter the Yellow Sea. And, speaking generally, the results of the conference do not in any way affect the validity of the author's conclusions, based as these are upon geographical rather than political considerations. Admiral Ballard's book deserves high commendation, both for its pleasing style and clear and well ordered method of presentation and because we have lacked hitherto anything in the way of a study, by a properly qualified writer, of the influence of the sea upon the destinies of the Far East during the historical period. A similar study, of that same influence during prehistoric times, still remains to be undertaken.

C. W. BISHOP

AN ARCHEOLOGIST'S LABORS IN THE NEAR EAST

E. A. W. BUDGE. **By Nile and Tigris: A Narrative of Journeys in Egypt and Mesopotamia on Behalf of the British Museum Between the Years 1886 and 1913.** Vol. 1, ix and 456 pp.; maps, ills; Vol. 2, viii and 456 pp.; maps, ills., index. John Murray, London, 1920. 63s. 9½ x 6½ inches.

The preface to these two handsome volumes by the Keeper of the Egyptian and Assyrian Antiquities of the British Museum indicates the character of the work—the results of over a quarter century's archeological labors in the Near East, given in narrative form. In the Prolegomena an account of the author's early studies, interesting for its personal touches, is of considerable value as a summary of the progress of our knowledge in this field in an important period (the seventies of the last century) regarding which little literature is available. Although we may not fully agree with his estimates of the character or work of those founders of Egyptology and Assyriology with whom he was brought in contact and in whose labors he participated, we can enjoy his careful and systematic collation of facts.

The first volume covers the period from 1886 to 1889; the second brings the narrative down to 1913. Both are crowded with detailed information with regard to the lands and peoples visited. In many ways the volumes would form an excellent guide to these regions because of their wealth of historical as well as archeological allusions. The facile command of resources, including a profound technical and linguistic training, and their skillful use in interpretation of the ruins visited call forth our admiration. Much of the narrative is written in a terse and pleasant style, though parts savor too much of the diary, marring the story and producing an unfortunate impression of padding.

Every traveler in the East will appreciate the sketch of the tiresome experiences met in dealing with Turkish and other officialdom and the author's shrewdness and diplomatic ability in handling such situations. We find that the ingenuity or perverseness of customs officers even can be made to serve the ends of science. Such for example is the suggestion that while "human remains" could not be exported, "bone manure" could.

Considerable space, including the final Apologia, is taken by the author to defend himself and the Museum's policy against various attacks. Some of these may be classed as blackmail and promptly dismissed; others are the work of defamers, probably envious of his successes; others the result of ignorance regarding the nature of the work. The whole history of the growth of the science of archeology goes to show that the natives of both Egypt and Mesopotamia have always destroyed, for their own reasons and purposes, all of

those records of the past upon which they could lay their hands. Instead of abuse the highest praise should be meted out to such men as the author whose energy and knowledge have done so much to preserve these treasures and make them accessible to all students of history. The magnificent collection of the British Museum in this field will always remain a splendid monument to the zeal and wisdom of its main collector, our author.

WILLIAM LIBBEY

COMMERCE AND COMMUNICATIONS BETWEEN SPAIN AND HISPANIC AMERICA IN COLONIAL DAYS

GERVASIO DE ARTÍÑANO Y DE GALDÁCANO. **Historia del comercio con las Indias durante el dominio de los Austrias.** 350 pp.; maps, ills. Barcelona, 1917. 9½ x 7½ inches.

CAYETANO ALCÁZAR. **Historia del correo en América (notas y documentas para su estudio).** 347 pp.; ill. Madrid, 1920. 9½ x 6½ inches.

These two books prove that we are beginning to acquire well established information regarding the means of commerce and communication between Spain and her American dependencies and within those dependencies themselves—information as useful to the geographer as to the economist and the historian.

Artíñano points out (p. 75) that all the navigation which served to unite Spain and her American holdings, so far as they were united, was modeled upon the fleet with which Columbus discovered the New World, this being so in point of administration and supervision by the government and in point of internal organization of the trading fleets. Modifications and developments of various sorts came into being, but the underlying principles were quite unchanged. By a royal *cédula* dated July 16, 1561, it was forbidden that ships should fare forth one by one; they must go in fleets, and, for protection's sake, many a merchantman was armed almost as fully as if she had been a man-of-war. Artíñano emphasizes the fact that cargo space lost on account of armament was compensated for by the government. This point shows plainly the close relationship then existing between the commercial wealth and the naval power of the Spanish empire. A royal *cédula* of November 3, 1567, provided for a fleet of 12 light, swift galleons to serve as convoys and protectors for the more purely commercial vessels (p. 103). This was known as the "Flota de Barlovento." This defense fleet suffered somewhat violent fluctuations, as did most of Spain's institutions in America, and in the middle of the seventeenth century it seems to have had a period of marked decline, for we find it being specially restored to activity by a *cédula* of December 23, 1667. But it was soon found that the colonists were unwilling to support the immense expense of its up-keep, and again it declined in importance (p. 105).

The earliest fleets to visit America were purely exploratory and military in their nature, but there followed a period of settlement in the new lands, and a commerce intended to fill the needs of the colonists came into being. The custom of using fleets was partly due to climatic conditions, for the most propitious season for traffic was found to be the summer months, and thus it happened that accidental fleets of independent ships were formed, all passing to America in April and May.

In addition to these conditions, there were regulations by the score touching upon who should and who should not go to America. These had a marked geographical consequence for the reason that, had the regulations been different, more Spaniards of both sexes would have gone to the colonies, and so the racial and anthropogeographical factors there would have been profoundly influenced by the influx of a more sizable Castilian element.

The work of Alcázar does for land communications much the same service that the work of Artíñano performs for sea travel. This does not mean, of course, that Alcázar has nothing to say about sea-borne mails. His first chapter gives a brief, but exhaustive, account of the courier posts which performed such important services in the Aztec and Inca empires before the coming of the Castilians. The geographical importance of those courier posts (services for the sending of messages by means of relays of swift runners) was, in those two empires, precisely similar to that of the analogous institution in the old Persian empire. They were huge political creations due to the genius of dominant tribes which had had such superior intelligence, initiative, and daring that, in each case, the directing tribe had learned how to overcome great geographical barriers of several kinds, and had so created a state of wide variations, both environmental and ethnographic.

Only the bringing into existence of machinery which would tend to minimize the effects of great distances would make the life of such a state more than transiently possible.

The succeeding chapters of Alcázar's work show that the Spaniards hardly equaled their predecessors in respect to the courier posts. In Chapter 2 is traced the history of the great post of Correo Mayor de Indias (Postmaster General of the Indies). On October 27, 1525, Charles V confirmed the appointment made by Ferdinand in 1514 of Dr. Lorenzo Galíndez de Carvajal as Correo Mayor de Indias. Haring (C. H. Haring: Trade and Navigation between Spain and the Indies in the Time of the Hapsburgs (Harvard Economic Studies, Vol. 19), Cambridge, Mass., 1918, pp. 34 and 35) states that the post remained in the Carvajal family until 1627, but that "the family of Carvajal seems to have retained control of some of the South American posts till 1768." According to Alcázar, however, the great office in question remained constantly in the hands of the Carvajal family until 1768. The powers and privileges accorded to the Correo Mayor were very important, as were also the obligations to which, at least on paper, he was bound to give fulfillment. Reading over the Capitulaciones between Luis de Velasco, Viceroy of Peru in 1596–1604, and the fourth Correo Mayor, Diego de Carvajal Vargas y Ortiz, signed in April, 1599, at Lima, one gets the impression that the postal service must have been admirable. So it was in theory; but one suspects that, in cold fact, such was not the case. In reality the very act of giving over such an important charge to one family was indicative of the manner in which the King of Castile often unconsciously collaborated with the geographic factor to create a very uneven distribution of Spanish authority and Spanish culture in his American possessions. No doubt many of the Correos Mayores were able men; but, even so, the patrimonial character of their office must have seriously interfered with whatever chances there were of its being put on a "strictly business basis."

Of the remaining chapters of Alcázar's book Chapter 7 (pp. 99–114), treating of the sea-borne mails, is especially interesting to geographers. Established in 1764, this service appears to have been a belated attempt to strengthen the ties between Spain and the colonies. Ships were to sail every month and make a rapid journey to America, carrying mail and passengers. The port of departure in Spain was La Coruña, and the American terminal was Havana, where distribution of the mails for delivery to various parts of America was made. Mails for Peru went by way of Buenos Aires, a sailing from La Coruña to that port occurring every two months. In other words, a mail service not very dissimilar to those of modern times came into being. If it had the desired result of lessening the gulf between mother country and colonies, that result came too late to prevent a rupture which had long since become inevitable.

PHILIP AINSWORTH MEANS

VEGETATION OF THE UNITED STATES

B. E. LIVINGSTON AND FORREST SHREVE. **The Distribution of Vegetation in the United States, As Related to Climatic Conditions.** xvi and 590 pp.; maps, diagrs., bibliogr. *Carnegie Instn. Publ. No. 284.* Washington, D. C., 1921. $9.00. 10 x 7 inches.

The aim of the present volume is "to bring forward certain types of the methods that may be employed in studying the etiology of plant distribution and to present some of the climatological data necessary to such work in the United States." The basic principles upon which the work is grounded, as set forth in the Introduction, are essentially two. (1) The plant in its relation to environment is regarded as a physiologically active organism, the visible manifestation of which is seen in "growth form." Vegetation is similarly looked upon as "the total plant population of an area viewed from the anatomical and physiological rather than the taxonomic and floristic standpoint": it is to be judged with reference to what the reviewer would term its physiognomy and ecological structure. "The study of vegetation *as such* has been, on the whole, greatly obscured by the fact that it has never been completely divorced from the study of the flora. Too much emphasis cannot be laid, at the present time, on the radical distinctness of the work of physiological plant geography, on the one hand, which attempts to relate the occurrence and distribution of species as physiological entities, to the factors of environment, and the work of floristic plant geography, or phytogeography, on the other hand—which attempts to reveal the geological history, the movements, and vicissitudes of species as phylogenetic entities." (2) It is assumed "as a law of

plant geography that the existence, limits, and movements of plant communities are controlled by physical conditions" and that "the conditions that control the broader geographical limits [of the community] are almost solely those of the climate." The work is divided into three parts, the essential features of which are outlined below, and is replete throughout with maps, tables, and graphs which will be welcomed by all workers in this field.

Part I has to do with the facts of vegetational distribution. Shreve's earlier account of the vegetation of the United States ("A Map of the Vegetation of the United States," *Geogr. Rev.*, Vol. 3, 1917, pp. 119–125) is here taken as the primary basis, his vegetation map being reproduced without change and the accompanying descriptive material with considerable amplification. This study is now supplemented, however, by a discussion of the distributional areas of various conformic groups of plants (i.e. of plants having the same growth forms) and also of a relatively large number of individual species, these latter so selected as to include a few of the dominant plants in each of the leading vegetations.

Part II is concerned primarily with the presentation of data to show the character of the leading climatic features in the United States, with particular reference to conditions of temperature and moisture which are influential in controlling plant distribution. For the solution of problems in plant distribution it is the conviction of the authors that climatological methods and climatological interpretation, as developed thus far, are "wofully inadequate" and that little real advance along this line can be looked for until many new methods have been devised and tested. "What ecological climatology requires is fundamental study of the climatic conditions *as these are effective to alter physiological processes*." The authors' own contributions in this field during the past fifteen years have been noteworthy and their present summary of climatic conditions is based partly on these and partly on the published work of other investigators.

In the discussion of temperature conditions, stress is laid on (1) their duration and (2) their intensity. As regards the duration of temperature conditions, the length of the period of the average frostless season is looked upon as having the greatest significance, other features taken into consideration being the length of the period of high normal daily mean temperatures and also that of low normal daily means. In the matter of temperature intensity, attention is directed to various indices of temperature efficiency in relation to plant activity during the average frostless period, viz. direct indices, remainder indices, exponential indices, and physiological indices, especial emphasis being placed on the latter; also to absolute temperature maxima and minima and to the mean normal temperatures for the year for the coldest fourteen days and for the hottest six weeks. On a basis of these various temperature criteria, a division of the United States is proposed into five temperature provinces, viz. very cool, cool, medium, warm, and very warm.

The moisture conditions dealt with are those of (1) precipitation, (2) evaporation, (3) aqueous vapor pressure, (4) relative humidity, (5) wind, and (6) sunlight. With regard to precipitation in its relation to plant activity and distribution, the normal mean daily precipitation for the period of the average frostless season is regarded as the most important single criterion, but account is also taken of the normal precipitation for this period plus the preceding 30 days, of the number of normally rainy and dry days and the length of the longest normally rainy and dry periods during the frostless season, and of the normal annual precipitation. With reference to these various precipitation criteria the United States is divided into four precipitation provinces, viz. humid, semihumid, semiarid, and arid. The names given these provinces are later applied to four corresponding provinces based on evaporation, on aqueous-vapor pressure, on relative humidity, etc. The evaporating power of the air as a climatic feature affecting plant distribution is regarded as being fully as important as precipitation, and the limited available data on this subject are considered in some detail, with particular reference to the conditions prevailing during the frostless season. Stress is further laid on the ratio between precipitation and evaporation, especially during the frostless season, and the method employed by Transeau ("Forest Centers of Eastern America," *Amer. Naturalist*, Vol. 39, 1905, pp. 875–889), somewhat modified, is extended to cover the whole United States. Aqueous-vapor pressure and relative air humidity furnish several moisture indices, the normal mean relative humidity index for the period of the average frostless season being regarded as the most valuable of all available desiccation indices by reason of the relatively large amount of accumulated data on this phase. The section on climate, which includes nearly fifty maps as well as numerous tables and graphs, concludes with an attempt at combining various series of moisture and temperature indices to obtain a single series of moisture-temperature indices, and on a basis of these the

division of the United States is suggested into twenty climatic provinces, viz. very warm humid, very warm semihumid, etc.

In Part III an effort is made to correlate the two bodies of data presented in Parts I and II in such a way as to learn the exact range of climatic conditions with which each plant or vegetation is associated. To this end, for each of the vegetations, plant groups, and plants discussed in Part I a table is presented (129 tables in all), on which are given the maximum and minimum values for each of the climatic conditions emphasized in Part II, and various comparisons are made between the positions of isoclimatic lines and lines drawn to show the limits of botanical areas, for the purpose of discovering correspondences. One interesting feature of this section consists in the cartographic presentation of the climatic conditions in each of the various vegetation areas here recognized and also in each of the "life zones" distinguished by Merriam ("Laws of Temperature Control of the Geographic Distribution of Terrestrial Animals and Plants," *Natl. Geogr. Mag.*, Vol. 6, 1894–95, pp. 229–238), the opinion being expressed with regard to Merriam's system that, while it formed an excellent beginning, it "will require much modification before it can become at all satisfactory to a serious student of etiological plant geography." The general conclusions of the authors regarding their own results are (1) that, while the parallelism existing between the distribution of many closely related climatic conditions makes it difficult in some cases to determine which of the several aspects of a particular condition is of greatest importance in controlling the distribution of a particular plant or vegetation, nevertheless the methods used rarely fail to demonstrate whether it is the temperature group of conditions or the moisture group that is of greatest importance; and (2) that in the case of the generalized vegetation areas of the United States one of the most clear-cut evidences of correlation is seen in the correspondence in position between the vegetation boundaries and the isoclimatic lines expressing certain values of the moisture ratio for the average frostless season.

It is unfortunate in many respects that the area treated by this work is bounded in part by political rather than geographic boundaries, since it seems inevitable that such unnatural limitations must lead to misconceptions in the case of vegetation regions which, with their accompanying climatic conditions, extend into areas that are not treated. This is true, for example, of the northeastern mesophytic evergreen forest, which attains its greatest development in Canada, being at best but poorly developed in the United States. It is also unfortunate, in the opinion of the reviewer, that somewhat more stress is not laid upon the *climax* character of the vegetation which typifies the great vegetation regions and particularly upon the relation of such climaxes not only to climate but to physiography. It may be quite true that "in the majority of the great vegetational areas with which we have to deal, the prevailing soil is a clay or a clay loam" and that "the prevailing vegetational types are, in the majority of cases, found upon this character of soil"; but there is at least one noteworthy exception to this rule, viz. the "southeastern mesophytic evergreen forest" of the Atlantic Coastal Plain. Surely this great plant formation of predominantly sandy soils cannot be compared with the formations of clays and clay loams without giving great prominence to the influence of physiographic factors in determining the nature of the environmental complex.

In any piece of work which deals with natural phenomena, however, where an attempt is made to bring out a correlation between cause and effect, personal bias is apt to lead to an undue stressing of certain features at the expense of others; and at any rate some difference of opinion is inevitable when it comes to the interpretation of the facts. The present work, without question, represents the most comprehensive effort yet made to interpret the known facts of plant distribution in this country in their relation to climate. It is the most searching investigation of the sort that has ever been published for any area of comparable size, and as such it is a milestone in the progress of climatological ecology.

GEORGE E. NICHOLS

A MANUAL OF ZOÖGEOGRAPHY

E. L. TROUESSART. **La distribution géographique des animaux.** 332 pp.; maps, ills., index. (Encyclopédie Scientifique; Bibliothèque de Zoologie, C. Houlbert, Director.) Librairie Octave Doin, Paris, 1922. 7 x 5 inches.

This volume is by a leading French authority on mammals, who has long been interested in the geographical distribution of animals. It is a new work and not a revision of his earlier "La Géographie Zoologique" (1890). The standpoint, however, has not changed materially

and is that of the faunal student primarily concerned with taxonomy, descent, and the genetic study of faunal areas as contrasted with the ecological point of view, or the relation of these animals to their environment, and thus it represents the older method of approach rather than the more recent. A truly balanced treatment will give equal weight to both points of view, and this is much needed today. Trouessart clearly recognizes the value of continental evolution, the geological history of their faunas, their migrations, centers of origin, and dispersal. In these respects he is distinctly modern.

About half the volume is devoted to those geographic factors which influence distribution, as composition of the medium, topography, altitude, climate, food, insular conditions, locomotion, migrations, transportation; and the migrations of birds receive special attention. The discussion of marine conditions includes the composition of the water, temperature, pressure, currents, migrations, the abyss; and the bionomic districts and faunal regions are outlined. The fresh-water fauna, including that of lakes and subterranean water, and finally the terrestrial fauna and that of caves are briefly characterized. While all these influences are ecological factors the viewpoint remains faunal throughout.

Considerable space is given to the discussion of the major terrestrial faunal regions and to listing their representative animals. The faunas of the sea are briefly outlined. The author calls attention to Houlbert's ideas that, among certain insects, the giants of the groups are indicative of their centers of origin; but there is no general discussion of the principles involved in the determination of such areas. He suggests that the fauna of the Fiji Islands indicates that this archipelago is a fragment of a submerged continent. Considering the book as a whole, it must be regarded as an important summary from the faunal standpoint and one that contains much of value to geographers and geologists, as well as to zoölogists, particularly to the student of mammals. We note that for the sake of brevity only a few references were given. This is unfortunate, as the author is well qualified to include many writings that would have enhanced the value of the volume.

CHARLES C. ADAMS

A DESCRIPTION OF THE WORLD'S CLIMATES

W. G. KENDREW. **The Climates of the Continents.** xvi and 387 pp.; maps, diagrs., bibliogr. index. Oxford University Press, American Branch, 1922. $7.00. 9 x 5½ inches.

Until the appearance of this book there was no English work that adequately covered the climates of the continents. Climatologists the world over have used Hann's "Handbuch der Klimatologie" for frequent reference and will continue to do so. But those not conversant with German have longed for some such book in English. British and American teachers of geography, especially, have had no textbook on which to base a course on the climates of the world and no ready reference work for their regional courses. Ward's "Climate Considered Especially in Relation to Man" could form only a valuable background for such studies.

In the introductory portion of the work the author gives a concise discussion of climatic statistics (Ch. 1) and of the pressure and wind systems (Ch. 2). Then in succession he presents Africa (78 pp.), Asia (108 pp.), Europe (65 pp.), North America (41 pp.), Latin America (42 pp.), and Australia and New Zealand (30 pp.). An American is struck with the relative brevity of the climatic discussions of North and South America but is thankful that Africa, Asia, and Europe are so fully treated. We have conveniently at hand a number of excellent publications covering the climatology of the United States and Canada but cannot so readily study the climates of the other continents. One reason for the small space devoted to American climatology seems to have been the author's lack of study of the numerous discussions to be found in the *Monthly Weather Review*, the *Annals of the Association of American Geographers*, and the *Geographical Review*. The rainfall maps of the United States used are wholly inadequate ones published nearly 30 years ago. In the discussion of temperature no mention is made of the now widely known heat of Death Valley, California, where under standard conditions a temperature of 134° F. was observed in 1913. Californians would have difficulty in recognizing their July temperatures on a map of "Mean [sea-level] temperature in July" (p. 279) which shows neither the heat of the Great Valley nor the coolness of the Sierra Nevadas. Snowfall is handled gingerly; and such baseless hearsay as "On the mountains of Wyoming a total fall of 180 feet is said to have been measured in one winter" is presented in lieu of definite information published in the *Monthly Weather Review* three to eight years ago and in the British *Quar-*

terly Journal of the Royal Meteorological Society nearly ten years ago. To show the distribution of tornadoes in the United States the author uses a map prepared 35 years ago when such statistics for much of the Middle West and the South were far from adequate. These are small points, however, and detract little from the otherwise comprehensive and interesting treatment of our climates.

The book is largely devoted to descriptions and explanations of the various climates and contains numerous references to their effects on man. Typical of the author's incisive style is the description of the dynamics of the meteorology of the heart of Asia (p. 155). Comparisons are frequently made between eastern and western coasts of continents and between the climates of places in corresponding locations on different continents. Valuable are the extensive tables of monthly average rainfalls and temperatures for about 420 stations on the various continents and their outlying islands. It is a pleasure to read such a well written, well illustrated, vivid, and accurate book, and a greater pleasure to commend it to others.

CHARLES F. BROOKS

GEOGRAPHICAL AND GEOLOGICAL OBSERVATIONS IN THE WEDDELL SEA AND ITS BORDERS

J. M. WORDIE. **Shackleton Antarctic Expedition, 1914–1917: The Natural History of Pack-Ice as Observed in the Weddell Sea.** Ills., diagrs., bibliogr. *Trans. Royal Soc. of Edinburgh*, Vol. 52, Part IV, No. 31, 1921, pp. 795–829.

J. M. WORDIE. **Shackleton Antarctic Expedition, 1914–1917: Depths and Deposits of the Weddell Sea.** Diagr., bibliogr. *Trans. Royal Soc. of Edinburgh*, Vol. 52, Part IV, No. 30, 1921, pp. 781–933.

J. M. WORDIE. **Shackleton Antarctic Expedition, 1914–1917: Geological Observations in the Weddell Sea Area.** Map, diagrs., ills. *Trans. Royal Soc. of Edinburgh*, Vol. 53, Part I, No. 2, 1921, pp. 17–27.

The voyage of the *Endurance* afforded an opportunity for 17 months' study of the ice of the Weddell Sea—December, 1914, to April, 1916. After the ship was destroyed in October, 1915, the party camped on the ice floes, finally escaping through the edge of the pack to Elephant Island.

The ice pack of the Antarctic closely resembles that of the Arctic despite the prevailing impression to the contrary. Sea ice may be divided into (1) fast ice, which remains fixed at least during the winter, and (2) pack ice. Described in terms of structure, it is young ice or hummocky ice. Young ice always has platy structure and a relatively smooth surface; while hummocky ice has generally become spotted or granular, and the surface has been broken and built up into hummocks.

In the Weddell Sea young ice formed usually in still water. Tiny horizontal plates of ice coalesced at the surface, forming a layer one-quarter to one-half an inch in thickness. Below, the arrangement of crystals was mainly vertical. Ice flowers were common on newly frozen leads in winter, forming apparently around surface brine bubbles as nuclei. Young ice frequently showed horizontal banding due to density differences; it was notably more plastic and less salt than old, hummocky ice.

Throughout most of the Weddell Sea the ice was constantly breaking up and drifting to the north and west. Of special interest were the cracks and other pressure phenomena resulting from the continual motion. Three principal types of cracks were noted. At very low temperatures, contraction due to a fall in temperature would cause cracks. Most common were cracks resulting from various strains. There were also cracks due to heavy pressure from the moving ice pack itself. It was easy to see how pressure was produced by the different rates of travel of floes of different density, size, shape, and thickness. "Every hummock acted as a sail." Floes were constantly overtaking one another, bumping, screwing, and swinging. Pressure was accompanied by bending, characteristic of thin, plastic ice; or in heavier floes by tenting, in which the ice rose in an inverted V; or, most commonly, by rafting, where one floe overrode another or dovetailed with it. The height of pressure ridges built up of blocks of sea ice has often been exaggerated. The pressure ridges seen in the Weddell Sea were rarely as high as 15 to 20 feet. An advancing pressure ridge would overload the ice and cause a weight crack to open ahead of the ridge and

parallel to it. Numbers of radial cracks, also, prepared the ice for further hummocking. The colliding of blocks of ice often caused chock cracks, likewise transverse to the pressure ridge.

The drift of the ice pack in the Weddell Sea was controlled by the wind direction, the deflective effect of the earth's rotation, and possibly by a current. As the prevailing wind was southeast, the ice took a westerly course, making the east coasts safest. During its travels notable changes took place in the ice. In the Weddell Sea, year-old ice not rafted attained a maximum thickness of about five feet, its growth depending largely on the snow covering. The age of a floe could be surmised from the discolored band marking the summer growth of diatoms in the ice. Ice either afloat or hummocked lost its fibrous character and became spotty or granular when subjected to temperatures around freezing. It also became gradually less salt; indeed hummocked ice, after a summer's exposure, became fresh enough to furnish drinking water.

In the ice cycles of the Arctic and Antarctic pack one conspicuous difference may be noted. In the Arctic, fresh pools from melting of the snow surface are common; in the Antarctic these rarely occur. In the Weddell Sea, surface melting would merely render the snow granular and not affect the ice beneath. The decay of the pack was caused mainly by the swell and mechanical breaking up of the floes. The blocks were then probably carried out through Bransfield Strait and finally melted in the open sea.

The soundings made in the Weddell Sea by the *Endurance* in 1915 supplement earlier observations and indeed cover parts of the sea where no previous soundings had been taken. Soundings were made frequently, usually when the ship was held by pack ice—the table shows a total of 52 soundings taken in the nine and a half months, December, 1914, to September, 1915, when sounding apparatus and specimens were necessarily abandoned through the loss of the ship.

The deposits obtained were mostly brownish or gray glacial muds, with occasional traces of sand. Very sandy deposits were found only off Coats Land and in latitude 70° S., longitude 40° W., though no land was visible from the latter location. Pebbles and rock fragments were most abundant along the Coats Land coast. In this vicinity quite a variety of specimens was obtained, but gray granite and gray to green grits were the only common rocks. Farther from land white quartzite and gray grit predominated. Apparently here, also, the source of the material was to the east.

The main bathymetrical results of the *Endurance* soundings were:

1. The 1000–2000-fathom lines apparently cross from Coats Land to Graham Land uninterrupted, making the existence of the so-called "Morrell's Land" highly improbable.
2. A deep channel appears to run southward through the middle of the sea.
3. East of the channel the bottom slopes gently up to the narrow, continental shelf off Coats Land. The irregularity of this shelf, together with the mountainous character of the snow-covered land, indicates hills and valleys in the rock beneath.
4. West of the channel the continental shelf rises more abruptly and is wider and more uniform. More than a hundred soundings were taken in four months of drifting back and forth on this shelf. These soundings were mostly at depths either from 180 to 190 fathoms or from 250 to 260 fathoms and showed a series of stepped terraces running southwest to northeast. Now the shelf of Antarctica is about twice the usual depth of continental shelves. One explanation offered is that the shelf was planed down by ice, formerly more extensive. This idea is disproved by the existence of these terraces, which would seem to indicate faulting. The depth of the shelf may be due to some earth movement, then, rather than to erosion. The *Endurance* failed to get satisfactory observations of the slope of the continental edge and obtained no new evidence on the relationships of the island groups to the north of the Weddell Sea.

The geological results of the Shackleton Expedition were limited, as no landing was made on the Antarctic continent. Mr. Wordie found that the edge of the continual ice sheet was practically everywhere afloat, and one iceberg twenty miles long was seen. The opportunities to study the geology of South Georgia and Elephant Island established, in the one case, the strongly folded character and largely Mesozoic age of the rocks and, in the other, provided information from an island on the inhospitable, precipitous shores of which the Shackleton Expedition made the first landing.

The eastern part of the northern shore of Elephant Island consists mostly of greenish schist. The island, which is some thirty miles long and perhaps fifteen wide, is youthful physiographically and shows evidence of submergence. Its interior appears to be a plateau

of 1500 feet in height from which mountains rise to over 3000 feet. Great glaciers tumble into the sea.

Although the geological similarity of Graham Land and South America no longer admits of any doubt concerning their morphological identity, their connection through the eastward bow of islands is by no means established by the last evidence obtained by Mr. Wordie. The rocks of South Georgia, the South Sandwich Islands, the South Orkneys, and Elephant Island differ markedly from one another and from those of Graham Land and South America. Only the folding is suggestive of relationship. Obviously the answer to the question can be established only by fuller charting of the ocean depths in this section.

CHARLES F. BROOKS

A MANUAL OF TIDES

H. D. WARBURG. **Tides and Tidal Streams: A Manual Compiled for the Use of Seamen.** vi and 95 pp.; diagrs. The University Press, Cambridge, 1922. 8s., 6d. 9½ x 7 inches.

Commander Warburg states that the primary purpose of this manual "is to explain the tides to seamen." Of the nine chapters comprising the text, the first is concerned with the tide-producing forces, the second with the tides as they exist; the five following chapters deal with the prediction of tides; the eighth is devoted to oceanic currents and tidal streams; and the last deals with tides and tidal streams in hydrographic surveying.

The greater part of the book is devoted to explaining the methods used in the prediction of tides, examples being given to illustrate the method of tidal differences and also the approximate prediction by means of harmonic constants. Very little space is devoted to what may be called the geographical aspect of the tides—the description of the tides and tidal phenomena actually found in nature; explanations for the existing variations in time, type, and range of tide; and the relations between tide and tidal currents.

The book is addressed to seamen and should prove useful in acquainting them with the harmonic method of tidal prediction and with the advantages of specifying the tide at any place by means of harmonic constants. However, the advisability of the author's departure from the usual procedure in two cases is open to question—the substitution of "semi-amplitude" for the amplitude of the harmonic constants and the change in the values of the astronomic arguments in the tables of the appendix, made necessary by the reversal of sign in these arguments.

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